Review on SPM for Evaporator, Radiator Leakage Testing Machine

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Abstract: *As title suggests it is Leak Test Machine. This machine is manufactured as per the customer's requirement and specific testing need. As the component is some form of a casting tube like structure which is leak tested. For this specific purpose and requirement of Leak Testing Machine the industry will train us in terms of design and manufacturing of whole machine. Testing method was the most important consideration. For which Testing method is selected according to the applications of component. According to the first meeting with the customer the specified their component details that the component is an aluminum casting and should be leak tested. As it is a casting component not a machined component, if a crack is detected on a casting component then it is of no use as casted component cannot be welded or machined to fill the crack. For this purpose, dry leak test method is appropriate. As customer just needs to notify that the component has a crack. He is not interested where the crack is. So, dry testing method is appropriate. When company needs to detect the location of the leakage of the component then we used the wet leakage testing method.*

Key Words: *As title suggests it is Leak Test Machine. This machine is manufactured as per the customer's requirement and specific testing need. As the component is some form of a casting tube like structure which is leak tested. For this specific purpose and requirement of Leak Testing Machine the industry will train us in terms of design and manufacturing of whole machine. Testing method was the most important consideration. For which Testing method is selected according to the applications of component. According to the first meeting with the customer the specified their component details that the component is an aluminum casting and should be leak tested. As it is a casting component not a machined component, if a crack is detected on a casting component then it is of no use as casted component cannot be welded or machined to fill the crack. For this purpose, dry leak test method is appropriate. As customer just needs to notify that the component has a crack. He is not interested where the crack is. So, dry testing method is appropriate. When company needs to detect the location of the leakage of the component then we used the wet leakage testing method.*

1. INTRODUCTION

Prof. Prashant Vavhal, has work on, Design and Assembly of Special Purpose Leak Testing Machine, according to his work, AS title suggests it is Special Purpose Machine (SPM). This machine is manufactured as per the customer'srequirement and specific testing need. As the component is some form of a casting tube like structure which is to beprecisely leak tested. For this specific purpose and requirement of Special Purpose Leak Testing Machine the industry willtrain us in terms of design and manufacturing of whole machine. Testing method was the most important consideration. For which Testing method is selected according to the applications of component. According to the first meeting with the customer the specified their component details that the component is an aluminum casting and should be leak tested. Asit is a casting component not a machined component, if a crack is detected on a casting component then it is of no use ascasted component cannot be welded or machined to fill the crack. For this purpose, dry leak test method is appropriate. As customer just needs to notify that the component has a crack. He is not interested where the crack is. So, dry testing method is appropriate.

The main objective of the project was to design and manufacture special purpose leak testing machine. In the first part component is studied in details for the forces and the calculations. The CATIA model of the fixture is drawn for simplification and understanding of the rough picture of fixture. The analysis is done for the forces bearing capacity of the fixture. The cylinders of the fixtures are selected according to the forces on the fixture. The specification is selected. The mounting of the cylinders is also important in the machine. The mounting is selected as front mounting for all cylinders. Manufacturing is done of fixture first and then it is attached to the main part of the machine. This is a stable part. After that testing is done at various pressures and the results are as required by the customer. Electronic circuitry is fitted for the automatic operation. PLC is used for the automation of the process. It is loaded with both the programs, one for dry testand second for the wet test. The machine is shipped to the required destination and received by the customer.

References (1)

Prof. Jalpesh Solanki, Prof. Hardik Acharya & Prof. Ajay Bhimani, has work on, Optimization of Defects Encountered in Manufacturing of Radiator, according to his work, 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. 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.

References (2)

McAuliffe Ashraf, has work on, The Design and Development of the Radiator Test Rig, according to his work, A radiator test rig could serve for the further analysis depends on the type of appositeness needed. It is all depends on the amount of heat transfer and how the surrounding factors could alter the amount. The volume of the flow rate and also the type of the working fluid are the major peculiarity that will be tested by using this radiator test rig, causing the changes in the rate of the heat transfer. Such phenomena created to replicate the same system applied in the real automobile system where it would cost in very large scale if those analyses and experiments carried out in that engine bay. Accumulated fluid will be heated up until certain optimum temperature. In this test, the range given is 80 degree Celsius. The temperature will be raised with the help of the heater element, where once the covet temperature is achieved, the system is ready to be tested. In conclusion, all the objectives set in this radiator test rig development have been achieved. By imitating this automobile radiator system, a radiator test rig could serve for the further analysis depends on the type of applications needed. The fan speed would obviously alter the cooling effectiveness of the system.

References (3)

A. N. Gowardipe, Ajay Deshmukh, Prashant Dimble, Akash Deshmukh, Nandkishor Garje, has work on, Leakage Testing Machine,according to his work,

As title suggests it is Leak Test Machine. This machine is manufactured as per the customer's requirement and specific testing need. As the component is some form of a casting tube like structure which is leak tested. For this specific purpose and requirement of Leak Testing Machine the industry will train us in terms of design and manufacturing of whole machine. Testing method was the most important consideration. For which Testing method is selected according to the applications of component. According to the first meeting with the customer the specified their component details that the component is an aluminum casting and should be leak tested. As it is a casting component not a machined component, if a crack is detected on a casting component then it is of no use as casted component cannot be welded or machined to fill the crack. For this purpose, dry leak test method is appropriate. As customer just needs to notify that the component has a crack. He is not interested where the crack is. So, dry testing method is appropriate. When company needs to detect the location of the leakage of the component then we used the wet leakage testing method. The main objective of the project was to design and manufacture special purpose leak testing machine. The project carried out by us made an impressive task in the various industries that needs to check the leakage testing of the various components such as casting component. This project has described methods for the finding the leaks and their location in the part and helps in the field of automation and also to improve quality. [4]

References (4)

Darshan Dabholkar, Dipak Shenvi, Nitin Kumar Anekar & Onkar Joshi, has work on, Design of Wet Leak Test Machine for Radiators: A Study, according to his work, this paper gives study of design of a wet leak test machine, used for the detection of leakages in radiators. It is based on the technique of submerging the part in the water that is stored in an immersion tank. Immersion tanks are a widely used method for location of leakages in complex assemblies and products. The part under test is pressurized with air while being submerged in a liquid, typically water. The operator looks for a stream of bubbles indicative of a leak. Proper selection and implementation of a production leak test method starts with an understanding of why the test is being performed, followed by establishing what the leak rate limit is, and finally a determination of how the leak test will be performed. In this paper, we have finalized the design for piston. The piston is used for generating the up and down movement of the platform which will bear the loads of the various radiators, which are selected for leakage testing. The piston movement is controlled with the help of the pneumatic timer circuit, which we have designed by using the SMC software. The designs for the tank and platform have been finalized. We have almost completed the entire design with only the support legs remaining. The theory regarding it has been finalized and the design will be confirmed as the final part of this procedure. A visit to the "Tata Toyo Radiator Ltd" campus has been planned to observe the testing of the machine and draw the final conclusions regarding the performance of the machine.

2. TYPE OF TESTING:

2.1 Air or Dry Testing- This method is most used for the testing any enclosed component. In this method, the component to be tested is first fully enclosed and a pressurized air is passed through it, the pressurized air in the component is checked through the 'COSMO LSR 700'. It is noted that if the pressure increases uniformly in the enclosed component, that means the component is okay. But if the pressure suddenly drops that means the component has a crack, then the component is rejected.

2.2 Water or Wet Testing- This method is used as is a secondary method of testing any enclosed component. In this method the component to be tested is first fully enclosed and a pressurized air is passed through it as like dry testing the pressurized air in the component. After that component deep in water tank which is held below the working table. It is noted that if the pressure increases uniformly in the enclosed component, that means the component is okay. But if the pressure suddenly drops and bubbles occur that means the component has a crack, then the component is rejected.

3. CONSTRUCTION

It consists of mainly;

3.1. Frame:

The frame is made of M.S. material. Lower part of frame is basically used to support the pneumatic components support mounted on it. That is Piston cylinder, Direction control valve are mounted on lower frame. On the upper frame vertical cylinder is mounted.

3.2. Pneumatic cylinder:

Our project is on Pneumatic control system. The Pneumatic piston-cylinder is an actuator which converts pressure of compressed air to displacement. When the pressure on one side of the piston is relatively higher than on the other side, it results in a linear displacement. The speed of traversal is proportional to the pressure difference. A double acting cylinder has two ports through which the supply of air is reversed to cause displacement in either direction. We used double acting cylinder to hold the wok piece that is to be weld.

Fig.3.1. Pneumatic cylinder.

3.3. 5/2 Valve DCV:

In our machine, we used two 5/2 valve to direct the flow of compressed air on the either side of piston for the reciprocating motion of same**.** The directional control valve must direst the flow from the compressor either to port A or port B. The fluid exhausted by the cylinder must be directed from the other port to back to tank. The valve shown has 5 ports and 2 positions so called as 5/2 valve. Valves are necessary to control the pressure, flow rate and direction of the fluid. Pneumatic systems are low pressure systems. Pneumatic valves are made from cheaper materials (e.g. aluminum and polymer) and are cheaper to manufacture. The directional control valve must direct the flow from the compressor either to port A or port B. The fluid being exhausted by the cylinder must be directed from the other port back to tank. The number of ports (External connections) and the number of positions describe such valves. The valve we used and shown above has 5 ports and 2 positions so it is designated as a 5/2 directional Control Valve. It is noted that the third position in a 5/2 valve is a center position. The air control mechanism inside 5/2 valve (usually a spool of some sort) is shifted into the center position inside the valve by one of two internal spring valve actuators. There is a spring located inside the valve at each end of the internal spool.

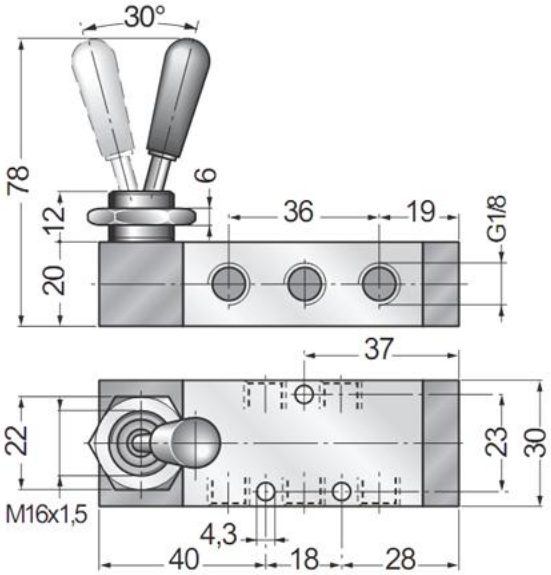


Fig.3.2. 5/2 Toggle DCV.

3.4. Pneumatic hoses and fittings:

This can be used for connection of pneumatic system with total drill assemble.

Fig.3.3. Pneumatic hoses and fittings.

3.5. Nut and Bolt:

As nuts and bolts are not perfectly rigid, but stretch slightly under load, the distribution of stress on the threads is not uniform. In fact, on a theoretically infinitely long bolt, the first thread takes a third of the load, the first three threads take three-quarters of the load, and the first six threads take essentially the whole load. Beyond the first six threads, the remaining threads are under essentially no load at all. Therefore, a nut or bolt with six threads acts very much like an infinitely long nut or bolt.

Fig.3.4. Nut and Bolt.

3.6. Compressor:

A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas. Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.

3.7. FRL unit:

Air leaving a compressor is hot, dirty and wet which can damage and shorten the life of downstream equipment, such as valves and cylinders. Before air can be used it needs to be filtered, regulated and lubricated. An airline filter cleans compressed air. It strains the air and traps solid particles (dust, dirt, rust) and separates liquids (water, oil) entrained in the compressed air. Filters are installed in the air line upstream of regulators, lubricators, directional control valves, and air driven devices such as cylinders and air motors. Pressure regulators reduce and control fluid pressure in compressed air systems. A lubricator adds controlled quantities of oil into a compressed air system to reduce the friction of moving components.

4. WORKING

In every radiator and evaporator manufacturing industry the main problem is leakage found in the casting, forged & welded component. Due to this various leakages problem are occurs after the components are assembled in actual working condition. Due to this faulty component break down in machine or equipment is occurred. In our machine we detect the various leakages formed in the casting component, forged component, welded component etc. In this machine we use the wet testing for the detection of leakages in the component or equipment. The air is blown in casting component for the checking the leakage of component with the help of compressed air. This compressed air is supplied by the pneumatic compressor. For this we use the pneumatic circuit by using various pneumatic valves and hoses. Then we dip the radiator and evaporator component in clean water tank for the detecting the location of leakage then we mark the location with help of marker. For these we used the pneumatic circuit. For checking the loss of air in the component we use visual testing, whichobserve passing air through the part of leak component. After that we can tell component is ok or faulty.

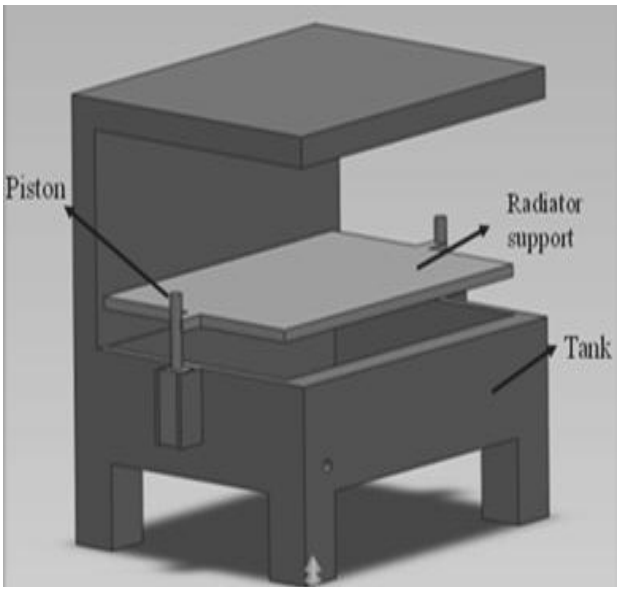


Fig.4.1. Concept of Radiator & Evaporator leak testing machine.

5. DESIGN

5.1. Metallurgical specification:

The machine is basically made up of mild steel.

Reasons:

1) Mild steel is readily available in market.

2) It is economical to use.

3) It is available in standard sizes.

4) It has good mechanical properties i.e. it is easily machinable.

5) It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure.

6) It has high tensile strength &Low co-efficient of thermal expansion.

5.2. Properties of Mild Steel:

M.S. has carbon content from 0.15% to 0.30%. They are easily wieldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases. Mild steel serve the purpose and was hence was selected because of the above purpose.

5.3. Approach to mechanical design of system.

In design the of parts we shall adopt the following approach;

Selection of appropriate material.

- Assuming an appropriate dimension as per system design.
- Design check for failure of component under any possible system of forces.

Mechanical design:

In mechanical design the components are listed down and stored on the basis of their procurement in two categories.

- Design parts
- Parts to be purchased.

For designed parts detailed design is done and dimensions there obtained are compared to next dimensions which are already available in market. This simplifies the assembly as well as the post production and maintenance work. The various tolerances on work are specified. The process charts are prepared and passed to manufacturing stage. The parts to be purchased directly are selected from various catalogues and are specified so as to have case of procurement. In mechanical design at the first stage selection of appropriate material for the part to be designed for specific application is done. This selection is based on standard catalogues or data books;

eg:- (PSG DESIGN DATA BOOKS) (SKF BEARING CATALOGUE) etc.

Assume the cylinder to be design by considering operating load as 5kg.= 49.5N

NOTE: if we increase the pressure of air as per formula pressure is directly proportional to the force.

If , **PF** ⇧ ⇧

Design of Pneumatic Cylinder:

Clavarino's equation for closed end cylinder at both ends. For ductile material use to determine the thickness of cylinder.

Let,

Material of the cylinder is Aluminum.

$$t = ri \left[\sqrt{\frac{\sigma t + (1 - 2\mu) P}{\sigma t - (1 + \mu) P}} - 1 \right]$$

S_{ut} =Ultimate tensile strength = **200N/mm²**

μ = Poisson's Ratio for the cylinder material =**0.29 (std-)**

di = Inner diameter of cylinder =**25mm**

Consider,

Double acting cylinder **Ø25X 100 (Diameter X Stroke)**

ri =12.5mm

By assuming pressure in working cylinder is, **P = 3 bar =0.3 N/mm²**

So according to Clavarino's equation,

For closed end cylinder at both ends to determine the thickness of cylinder.

Assume,

p = 3 bar = 0.3 N/mm²

μ = 0.29

r_i = 12.5mm.

$$t = r_i \left[\sqrt{\frac{\sigma_t + (1 - 2\mu) P}{\sigma_t - (1 + \mu) P}} - 1 \right]$$

$$t = 12.5 \times 1 \left[\sqrt{\frac{200 + 0.3 [1 - (2 \times 0.29)]}{200 - 0.3 (1 + 0.29)}} - 1 \right]$$

$$t = 12.5 \times \left[\sqrt{\frac{200.126}{199.613}} - 1 \right]$$

t = 0.916mm.

Available thickness, **t = 1mm**

Piston dia- = 25mm

Stroke dia- = 100mm

Piston rod dia- = 10mm.

Let,

A= Force area of cross-section of piston.

$A = \frac{\pi}{4} (D^2)$ mm²

$A = \frac{\pi}{4} (25^2)$ mm²

A= 490.87 mm²

A_{PR}= Force area of cross-section of piston on rod side.

$A_{PR} = \frac{\pi}{4} (D^2 - d^2)$ mm²

$A_{PR} = \frac{\pi}{4} (25^2 - 10^2)$ mm²

A_{PR}= 412.334 mm²

Time required to complete stroke is 2 second.

Linear velocity of piston $\mathbf{V} = \frac{L}{t}$

$= \frac{100}{2}$

= 50 mm/sec.

Piston force acting during forward stroke.

$F_{a= P X} \frac{\pi}{4} (D^2)$

= 0.1 X 490.87

F_a = 49.087 N.

Piston force acting during return stroke.

$F_{R= P X} \frac{\pi}{4} (D^2 - d^2)$

= 0.1 X 412.33

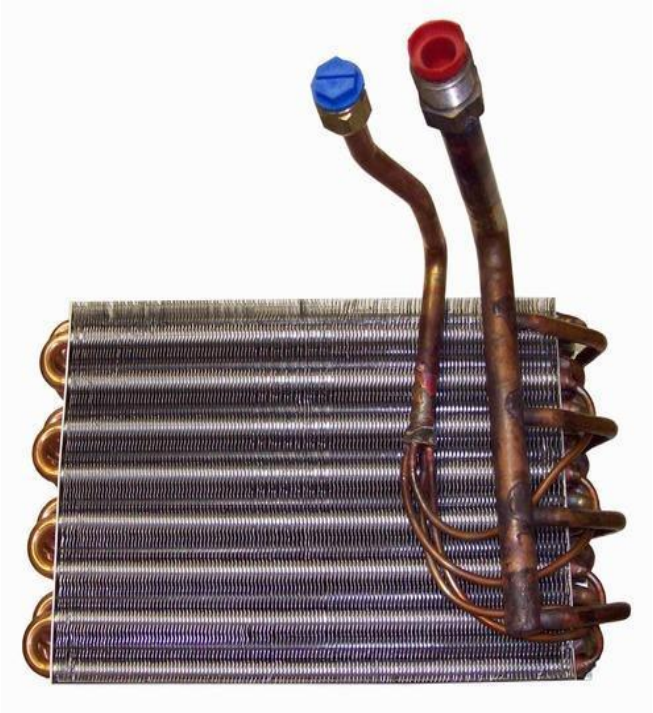
F_R = 41.233 N.

ADVANTAGES

1) Easy loading of component and pneumatic clamping system for sealing between dummy tank and body.
2) This technique offers leakage detection in accuracy
3) It is especially useful in high volume applications, and leak detection and location is very economical.
4) Machine work on the low power consumption.
5) The operation of the new machine is well controlled, Well balanced system.
6) Only simple support structures are required Design & fabrication is easy.
7) It is a faster process of testing.
8) Initial investment is low.
9) More accurate and economical in mass quality checking.
10) It minimizes misalignment & less floor space is required.
11) It increases the safety and working condition.

APPLICATION

1. Very widely used in the automotive industries for the leakage testing of various casting components such as engine parts, radiators, etc.
2. Used in the Refrigeration industry.



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