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DESIGN AND ANALYSIS OF SPECIAL PURPOSE MACHINE FOR LEAKAGE TESTING OF DIESEL TANK

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Abstract: - In automobile tanks without leak detection, leaks were discovered late, after contamination had spread, requiring difficult and costly cleanups. It is also very dangerous due to ignition of fuel. By contrast, if you have effective leak detection, you can respond quickly to signs of leaks. You can minimize the extent of environmental damage and the threat to human health and safety. Early action on your part also protects you from the high costs that can result from cleaning up extensive leaks and responding to third-party liability claims. There are many methods and types of test equipment for solving these problems. Each test method is suitable only for a specific leak rate or for fixed forms and technologies. In most instances where leak detection is used, explicit leak rate measurement is not required, but the system must be able to recognize if the leak rate is above or below a specified level. Presently the empty tanks are filled with compressed air and sealed at oil inlet. And then the tank is immersed in water reservoir and tested for air bubbles coming out of leakage by an operator by his open eyes. Now a days this method is done manually which require 2 to 3 people for forced immersion and visual inspection just like detection of puncture of tyre. After some use, water gets contaminated and also due to improper reservoir, there is fatigue in operating oil tank. There is no consistency in result. So there is need to do this work automatically. So we have designed special purpose machine (SPM) for leak detection of tanks. Firstly we have decided to make a design of Special Purpose Machine and further to make analysis of important part. The purpose of this system is to detect leak, if any, in the component under test by air pressure & water dip method. The equipment is designed for finding leakages, if any, in the Casting by pressure decay method. If this method reveals leakage, then water dip test can be conducted to find exact location.

Keywords: Leakage Testing, Diesel Tank

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INTRODUCTION

Tanks are used for storage of fuel like diesel, petrol etc. for internal combustion engines. Oil tanks are fabricated by pressing the sheet metal and welding. Due to improper welding, there is leakage of oil through the seams (joints). Critical leak spots in closed systems are usually connections, gaskets, welded and brazed joints, defects in material, etc.In automobile tanks without leak detection, leaks were discovered late, after contamination had spread, requiring difficult and costly cleanups. It is also very dangerous due to ignition of fuel. By contrast, if you have effective leak detection, you can respond quickly to signs of leaks. You can minimize the extent of environmental damage and the threat to human health and safety. Early action on your part also protects you from the high costs that can result from cleaning up extensive leaks and responding to third-party liability claims. There are many methods and types of test equipment for solving these problems. Each test method is suitable only for a specific leak rate or for fixed forms and technologies. In most instances where leak detection is used, explicit leak rate measurement is not required, but the system must be able to recognize if the leak rate is above or below a specified level. This acceptance level is the main parameter to consider when selecting the appropriate method or combination of testing methods. Several other factors must be taken into account. In particular system costs, complexities, environmental impact, reliability, influence of external conditions, operator dependence and user-friendless should also be considered. Leak testing is a nondestructive test method that provides the capability to detect the liquid or gas escaping from a sealed pressure system and to locate the individual leaks for possible repair.

2.0 OBJECTIVE

Presently the empty tanks are filled with compressed air and sealed at oil inlet. And then the tank is immersed in water reservoir and tested for air bubbles coming out of leakage by an operator by his open eyes. Now a days this method is done manually which require 2 to 3 people for forced immersion and visual inspection just like detection of puncture of tyre. After some use, water gets contaminated and also due to improper reservoir, there is fatigue in operating oil tank. There is no consistency in result. So there is need to do this work automatically. So we have designed special purpose machine (SPM) for leak detection of tanks. Firstly we have decided to make a design of Special Purpose Machine and further to make analysis of important part. Different theories and concept are considered with deferent designing criterion for fixture design. By using these we have to

3. 0 LITERATURE REVIEW

3.1 Leak Testing Methods

A leak can be defined as an unintended crack, hole or porosity in an enveloping wall or joint, which must contain or exclude different fluids and gases allowing the escape of closed medium. Critical leak spots in closed systems are usually connections, gaskets, welded and brazed joints, defects in material, etc.

Non-destructive testing (NDT) is a noninvasive technique for determining the integrity of a, component or structure. Because it allows inspection without interfering with a product's final use, NDT provides an excellent balance between quality control and cost-effectiveness.

A leak test procedure is usually a quality control step to assure device integrity, and should preferably be a one-time non-destructive test, without impact on the environment and operators. Several leak-testing techniques are available, spanning from very simple approaches to systems that are more complex. The most commonly used leak test methods are underwater bubble test, bubble soap paint, pressure and vacuum decay, and tracer gas detectors (halogen, helium and hydrogen). The first three techniques, due to their characteristics and sensitivity, can be used only for gross leak detection. Tracer gas leak testing methods are much more precise than the previous group but, in many cases, their theoretical sensitivity is more than is required. In a practical sense, however, this is limited by environmental and working conditions.

The “major six” (or basic) NDT methods, which are largely used in routine services to industry, are: •

• Visual inspection

• Liquid penetrate testing

• Magnetic particle testing

• Electromagnetic or eddy current testing

• Radiography

• Ultrasonic testing

In the graph below, the performance of various leak-test techniques are summarized.

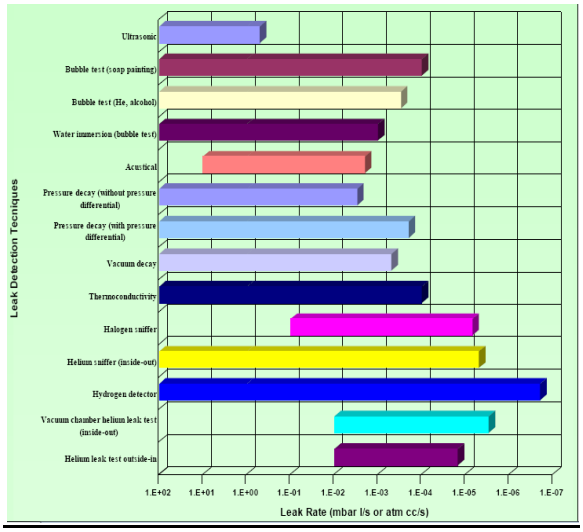

Figure No. 3.1- Various Leak Detection Techniques vs. Leak Rate.

From the graph it is seen that hydrogen detector method shows highest leak detection rate from the other technique but main disadvantage of this method is high cost of hydrogen. Also hydrogen is very explosive. So we select water immersion bubble test method because of easy availability of water.

3.2 Water Immersion Bubble Test Method

The water-immersion bubble test, also called "bubble testing" or "dunking", is a traditional and relatively primitive technique of leak detection. It consists of immersing a charged or pressurized part, usually with high-pressure dry air or nitrogen, in a water tank and watching for escaping bubbles. The larger and more frequent the bubbles, the bigger the leakage.

Following requirements can be used to improve this method.

Increasing the internal pressure in increments may increase the probability of finding a leak and can be less time-consuming in pinpointing the leak.

A detergent can be added to the water to decrease surface tension, which helps to prevent the leaking gas from clinging to the side of the component.

Using different gases (e.g. helium) and/or liquids may give some advantages in system performance, but at a cost disadvantage.

Hot water in the tank sometimes helps to increase the pressure inside the component or piping system. If dry nitrogen is used, this does not help because nitrogen does not increase its pressure significantly. If refrigerant is contained in the system or component, it may help considerably to increase the pressure and, therefore, increase the chance of finding the leak. In conclusion, this technique does offer leak detection accuracy in the 10-3 mbar · l/s range in high volume production applications and, in most cases, leak location and is very economical. So we select this type of method for leak detection. Design and manufacturing of fixture can be time consuming and it increases the time consuming, and it increases the manufacturing cycle time of any product that needs machining and/or assembly. The main reason was that fixtures were designed to tight tolerances typically 30-50% of the overall work piece tolerance.

4.0 SYSTEM DEVELOPMENT

4.1 Purpose of the SPM

The purpose of this system is to detect leak, if any, in the component under test by air pressure & water dip method. The equipment is designed for finding leakages, if any, in the Casting by pressure decay method. If this method reveals leakage, then water dip test can be conducted to find exact location.

4.2 Material Selection

Material selection is one of the key considerations in producing fuel tanks. The three most common materials used in the manufacture of fuel tanks are aluminum, steel and stainless steel. Regardless of the choice of material, the quality of the selection must be such as to allow that material to be malleable enough to be bent, rolled and stamped into formation.

The majority tanks manufactured today are made of steel. The selection of steel and stainless steel should be that of prime grade material. An important consideration in manufacturing is choosing material suitable for stamping and bending. The material must be ductile enough to be bent and formed yet thick enough to provide strength and to accept a weld. This is especially true for tanks of a design that require sharp bends.

4.3 Major subassemblies

The machine consists of following major subassemblies:

- Frame/Structure.
- Water Reservoir

- Water Tub
- Component locating & holding mechanical fixture MS/ SS (Optional)
- Control Valve cluster
- Pneumatic cylinders & Controls
- PLC Based Electrical Control Panel.
- Leak Controller

These parts can be supplied along with the machine if required.

4. 4. Modeling

Solid Modeling of the Leakage Testing Machine using Pro/ENGINEER 5.0

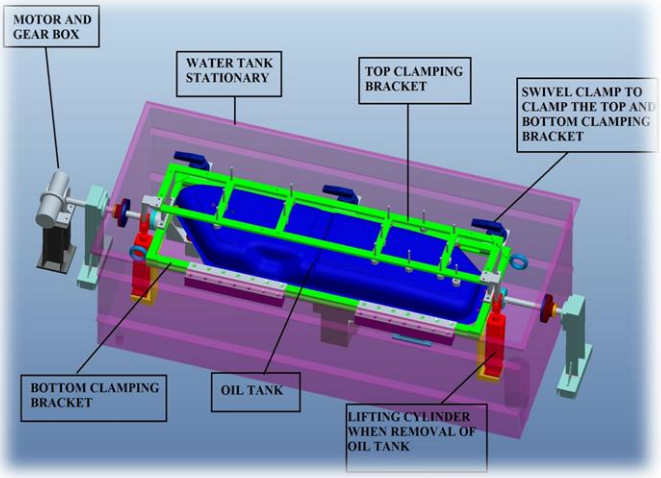

Figure No. 4.1 Assembly of SPM.

4.5. Sequence of Operation

4.5.1 Leakage Detection by Auto leak detector

- Locate component on the fixture.
- Push cycle start button.
- Components will be clamped with Pneumatic Cylinder.

- Hold it for Preset time (Test Time)
- During hold time of 30 sec (Settable), leak detector detects the drop in pressure due to leakage if any & pressure readings will be displayed on controller.
- If controller indicates pressure drop, which is above set value (Presettable) then components is rejected. Buzzer is activated for preset duration or till acknowledge button is pressed.
- If the pressure drop is less than set value, then component is accepted. Audio chime is activated for preset duration. DOT punch will make DOT on the component under test (axle banjo).
- Air will be released from the component.
- Clamping cylinder will get declamped.
- Unload the component.
- Repeat the procedure for next component.

4.5.2 Leakage Detection by Water Dip Method

- If the component is found leak with electronic leak detector then the test cycle goes for the water dip cycle as below.
- If leakage detector shows component as leak press 'Accept' push button.
- Air will get filled in the component.
- Simultaneously water will get filled in the water tub so that component will get dipped
- Operator will watch the component visually for leakages for 30 seconds (settable)
- Component will rotate in Clock wise direction.
- Operator will watch the component visually for leakages for 30 seconds (settable)
- Component will rotate in anti-clock wise direction.
- Component will come to home position.

- Water will get released through the water tub.
- Air will get released from the component.
- Component will get decamped.
- Operator will remove the component from the fixture.
- Machine is ready for the next cycle.

5. PERFORMANCE ANALYSIS

5. 1. Analysis of System

The complete procedure of analysis has been done using ANSYS-10.

5. 1. 1 Analysis of shaft

Analysis of shaft is very important in this project because all loads are carried away by the shaft. The support and force acting on the shaft is shown as below.

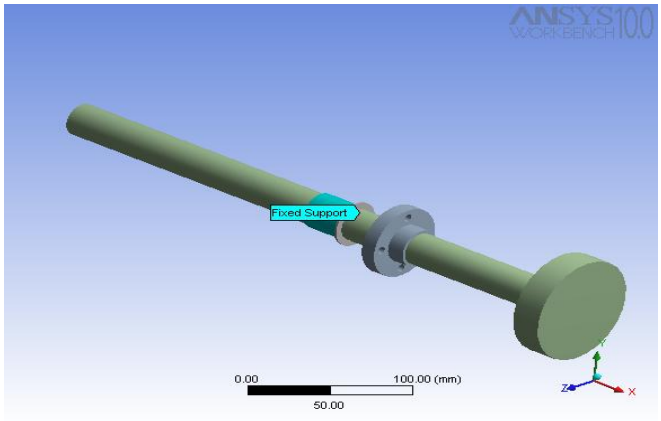

Figure No 5.1: Fixed support acting on shaft

5.1.2 Structural Loading on shaft:

Total force acting on shaft is 1420 N. So each shaft having 710 N force acting on vertically downward direction.

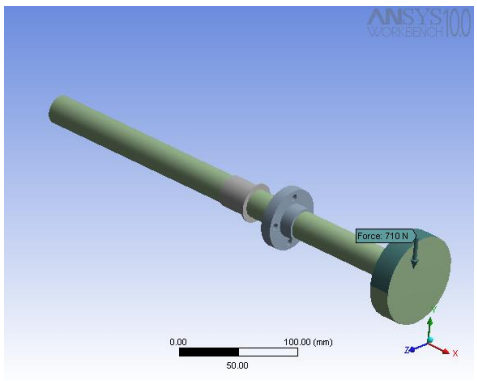

Figure No 5.2: Force acting on shaft.

5.1.3 Deformation of shaft:

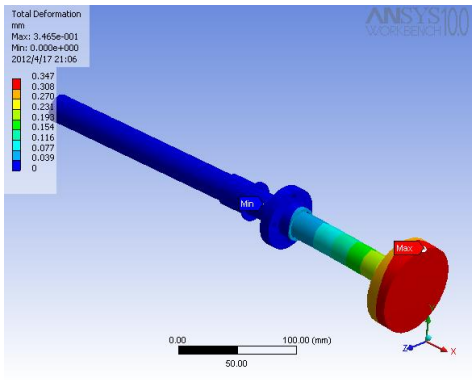

Figure No 5.3: Deformation of shaft.

5. 1. 3 Deformation of shaft:

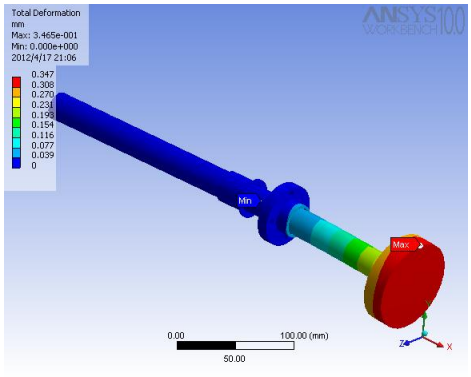

Figure No 5.4: Deformation of shaft

5. 2 Analysis of top clamp assembly

5.2.1 Structural supports:

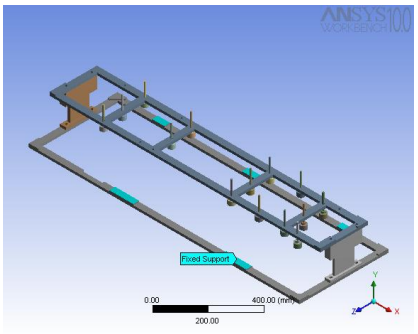

Figure No 5.5: Fixed support acting on top clamp.

5.2.2 Structural Loading on top clamp assembly:

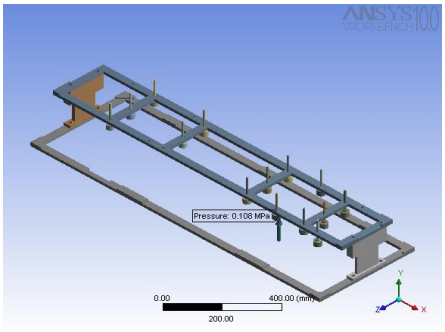

Figure No 5.6: Force acting on top clamp.

5.2.3 Deformation of top clamp assembly:

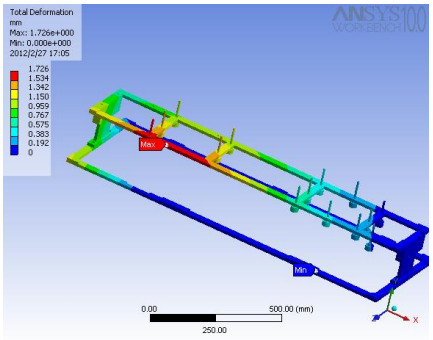

Figure No 5.7: Deformation of top clamp assembly.

5.2.4 Stresses on top clamp assembly:

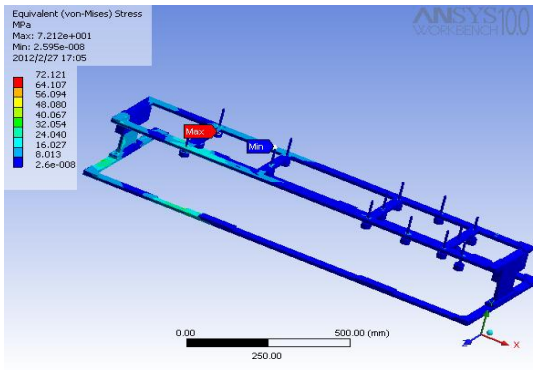

Figure No 5.8: Stresses on top clamp assembly.

As the finite element analysis of shaft and top clamp assembly is performed using ANSYS-10 detailed, it can be observed that the stresses and deflections are within desired limits

6. CONCLUSION

The work presented in the report is an attempt in designing a special purpose machine of a given dimension. Extensive literature review was carried out to study the various methods of leak detection techniques. A suitable technique was chosen from the available methods to for testing the oil tank. Pro/ENGINEER 5.0 is used extensively for making parts with different types of operations. Then all the parts are assembled for making a complete special purpose machine in Pro/ENGINEER 5.0 in assembly section. We have done analysis of shaft and top clamp assembly in ANSYS WORKBENCH 10.0 which gives us suitable data for manufacturing.

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