International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 09 | Sep 2021 www.irjet.net p-ISSN: 2395-0072

Leak Detection of 4 Liter, 7 Liter Fuel Tank as well as Vacuum Tank after Seam Welding

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Abstract – *When leakages were discovered at late in case of without leak detected fuel tanks, after spreading of contamination; then there is requirement of difficult and costly cleanups. As there is possibility of combustion of fuel inside of the tank, it is very dangerous. In other case, if there is effective system for leak detection in tanks then proper actions can be taken on those leaks to avoid spreading of contaminants. Early actions on leakages in fuel tank will reduce the cost of cleaning up extensive leaks. There are so many methods for the detection of leakages in tank. These testing methods are varied for different rate of leakages. The leakage system must be able to endorse if the rate of leakage is above or below a specified level. During detection of leakage, the tank is filled with full of compressed. This tank is immersed in water reservoir and tested for air bubbles coming out of leakage by an operator. There is requirement if two to three peoples for this process of leak detection in tanks by water emersion method. Detection of leak is the main purpose of this system by using water dip method. If this method reveals leakage, then water dip test can be conducted to find exact location.*

Key Words: fuel tank, vacuum tank, seams welding, leakage, leakage detection.

1. INTRODUCTION

The detection of leakage in fuel tanks as well as vacuum tanks is implemented to verify the integrity of manufactured part. It involves complete testing or sample inspection. The main goal of leak detection is to eliminate leaky parts to reduce spreading of contamination. During manufacturing process of tanks, raw material is transformed into a final product. The manufacturing process starts with the product design as well as specification of materials begins from which the product is made.

In the manufacturing of fuel tanks, tanks must be leak tested to ensure that there is no any leakage of fuel. The basic functions of leakage testing are as follows,

1) Determination of presence of leakage
2) Measurement of leak rate and
3) Leakage location.

There are variety of methods and number of test equipment for solving these problems, but unfortunately there is no any unique technique, that fits for every kinds of situation. Each testing method is suitable only for a specific rate of leakage.

1.1 WELDING

Welding is the process of fabrication, which joins two or more materials by melting them. In this process of welding, metals or thermoplastics are melted together to join and then allowed them for cooling. The process of welding is different from the process of lower temperature metal joining techniques such as brazing and soldering.

For the melting of base material, a filler material can be added to joint. This forms a pool of molten material. This weld pool is cooled to form a joint. This weld can be stronger than that base material. To produce weld, pressure may also be used in conjunction with heat. To protect filler material from being oxidized, it requires a form of shield.

1.2 SEAM WELDING

The basic difference between seam welding and resistance spot welding is that the welding electrodes are motor driven wheels rather than stationary rods. In seam welding, sheets of metals are held together by a mechanical force in a lap configuration between shaped copper electrodes and joined by passing an electric current through the sheets. As with other types of resistance welding, fusion is produced where the sheet surfaces come into contact due to this being the point of highest electrical resistance and thereby the place where heat generation is at its greatest.

Seam welding is resulting in a rolling resistance weld or a non-hermetic seam weld because; the heat from the disc-shaped electrode wheels creates a continuous weld as the work pieces are fed between them.

Resistance seam welding can either use an intermittent motion, where the speed of the roller is not predetermined, or continuous motion seam welding where the speed of the electrode roller is predetermined before the current is supplied.

2. LITERATURE SURVEY

From the study of various journals on leakage detection of fuel as well as vacuum tank literature review is carried out as follows,

Behbahani-Pour MJ et al. (2016) have published that there is possibility of ignition at the leakage of fuel from the aircraft's tank, so it is required to detect fuel leakage before the aircraft departure. This work aims to present a technique of fuel leakage detection which can be used on large transport airplanes. The method used in this research work requires the fuel vent ports on the wings to be replaced with fuel vent valves, can be controlled in open or closed position. After conduction of number of experiments it is concluded that, there is leakage of one liter fuel per minute. This leakage on large transport airplane is very serious problem. The hypothesis can be used for the measurement of fuel leakage by measuring the pressure drop in tank ullage area. The basic bourdon tube pressure gauge can be used to detect the changes in ullage pressure.

SHAIKH FAYUM JAINODDIN et al. (2015) have researched on leakage testing of diesel tank. This leakage is very dangerous due to ignition of fuel. It also requires costly cleanup for leaked fuel. The empty tank filled with pressurized air and immersed in water to detect the problem of leakage same as to punctured tire, i.e. air bubbles coming out from the tank. For this method there is requirement of two to three persons for water immersion and visual inspection. Special purpose machine is designed for the detection of leakage automatically which is cheaper than water dip method.

S.B.Kakuste et al. (2014) have described various methods for finding the leakages with their locations. The confirmation about existence of leakage is given by pressure difference obtained by the pressure decay test whereas leakage location can be pinpointed by water immersion test. These methods have not only good accuracy but also quick results.

Andrej Pregelj et al. (1997) have researched on critical leak spots in closed systems are connections, gaskets, welded and brazed joints, defects in material etc. Detection of leakage with its location is main problem, which can be solved by using variety of treatments and techniques. There is no any unique method for leakage detection with pinpointing. This research work represents the types of leakages, their sizes and various techniques for pinpointing the leakage.

3. PROBLEM STATEMENT

The major problem while using leaked fuel tank or vacuum tank is the reason for loss of fuel. When leakages were discovered at late in case of without leak detected fuel tanks, after spreading of contamination; there is requirement of difficult and costly cleanups. If gasoline come into contact with a source of heat, causes an explosion; it is also very hazardous due to ignition of fuel. Therefore, it is required to testing of leakage in fuel tank as well as vacuum tank after seam weld to reduce contamination and hazardous effect of explosion.

4. OBJECTIVES

A. To check the rate of leakage of fuel tank as well as vacuum tank to avoid spreading of contamination.
B. To achieve location of leakage after seam weld of fuel tank and vacuum tank.
C. To reduce the cost rework process on fuel tank and vacuum tank.
D. To save time for detecting the leakage area in fuel tank and vacuum tank after seam weld.

5. LEAKAGE

An unexpected crack, hole or porosity in an enveloping outer wall or joint, which must comprise or exclude different kinds of fluids as well as gases allowing the spilling from closed medium, is known as leakage. For localization and size measurement of leakages in sealed products, leak detection method is used. For majority of examples, a leakage test procedure is a quality control step to assure righteousness of device and is one-time nondestructive test. Any defects in the containing envelope of the tank, which results in production of leakage. For example, a very glassy wall of a plastic bottle becomes imperceptible cracked at enough hoarse pressure difference, or in canning diligence if the score mark is too deep in ring pull-tab can top, or spongy cast in machine housing metallurgy etc. In newly manufactured products leakages are found at most commonly scrappy joints or seals by which number of parts are assembled to build the final article. There are so many immovable joints; between them the mostly antiquated are braces, O-rings, other gaskets, brazed and soldered joints tessera-to-metal and ceramic-to-metal seals etc. Materials permitting gas dissemination and permeation through the wall. In vacuity technique, virtual pore is the special type of leakage, which is not really a leakage but is the internal root of gas or steam. These are vacuities in a chamber wall with sleazy connections to the inner utensil space such as indecent welds, closed threads and holes etc.

6. LEAKAGE IN SEAM WELDING

The procedure for testing of leakage is usually a quality control step to assure integrity of device and should be preferred as a one-time non-destructive test, which does not impact on the environment and operators. "An unintended crack, hole or porosity in an enveloping wall or joint, which must contain or exclude variety of fluids as well as gases allowing carrying away from closed medium, is known as leakage". The variety of connections, gaskets, welded and brazed joints, material defects are critical spots of leakages in the closed systems. The sufficient amount of pressure inside fuel tank is suggested by digital gauge with light.

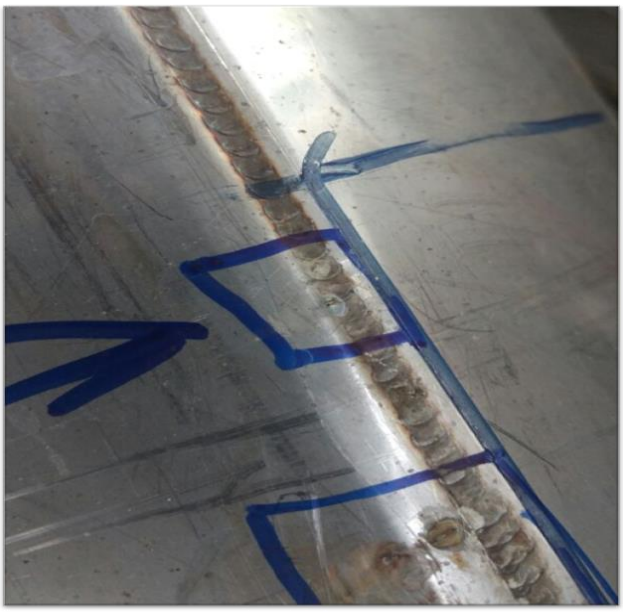

Fig -1: Leak detected in seam welding

Lower the chance of miss-read fatigue human eyes after long hour's operation compared with traditional gauge. The device used for testing of leakage is operated according to the operating manual, which is tail or made for every fuel tank. The leakage testing operation is performed for different capacity of fuel tanks with different ranges of pressures.

If visible bubble will burst out from leakage area of tank, then there is presence of leakage. Any kind of leakage will be easily detected under this environment.
There are so many techniques of leakage testing available, spanning from very simple approaches to systems that are more complex. Underwater bubble test method, bubble soap paint method, pressure and vacuum decay and tracer gas detectors (halogen, helium and hydrogen) are the most commonly used techniques for testing of leakages. The first three techniques, due to their characteristics and susceptibility, can be used for detection of leakage. On comparing with the previous group tracer gas leakage detection methods are much more precise, but in many cases, their theoretical susceptibility is more than is required. In a tactful discretion, however, this is constricted by environmental and working conditions.

7. EFFECTS OF LEAKAGE

Any leakage of fuel in fuel tank can become very harmful if not dealt with. Besides the faulty economy of fuel, the vehicle may also be passionate to fire or an explosion.
If the system has a leakage; the vacuity gauge will continue to rise until the condition of atmospheric pressure has been reached. However if the system is firm of vacuity but still contains humidity the rise will level off when the vapor pressure equalizes in the system.

8. METHODS FOR CHECKING LEAKAGE IN SEAM WELD

A. Water immersion bubble test method.
B. Soap solution bubble test.
C. Vacuum chamber inside-out leak testing.

Fig -2: Leakage detection system for fuel tank and vacuum tank

A. Water immersion bubble test method

The method of water immersion bubble test is a traditional and most commonly used technique for detection of leakage and also called as "bubble testing" or "dunking". In this method of water immersion bubble test, tank is filled with pressurized dry air or nitrogen. This charged or pressurized part is immersed in a water tank and kept for watching of escaping air bubbles from the sealed tank. If larger and more frequent bubbles are found, then leakage is bigger. There is also possibility of small leakage at the tank, but it is very difficult to detect. The minimum detectable rate of leakage is limitation of this method of water immersion bubble test.

Some tricks can be used to improve this method-

- The quick method for pinpointing the leakage is achieved by increasing the internal pressure in increments may increase the probability of finding a leakage.
- To decrease surface tension, detergent can be added in the water, which helps to prevent the leaking of gas from clinging to the side of the component.
- Using different gases such as helium and liquids may give some benefits in experiment of the system, but at a expense disadvantage.
- Hot water in the tank sometimes helps to increase the pressure inside the component or piping system. If oasis nitrogen is used, this does not help because nitrogen does not increase its pressure expressively.

B. Soap solution bubble test

In this method of soap solution bubble test, tank is filled with pressurized dry air or nitrogen and sealed its openings. Instead of submersing this charged or pressurized part in water, the outer surface of tank is sprayed with soap solution. The operator can see where the air bubbles escaping from the tank, there is the presence of leakage. There are various types of soap solutions are available in the market. Some of the soap solutions are applied with the help of brush on outer surface of the tank. Some of the brands of soap solutions can be sprayed to cover the large area in short amount of time. This is advantageous technique, but it is time consuming during cleaning. Soap solutions have also added with antifreeze agent, which prevents them against freezing during winter season. Very small leakages can be detected by soap solution method. Soap solution method is very sensitive on comparing with water immersion method. This soap solution method is enomously antiquated when the approximate area where a possibility of leakage. In this case, for pinpointing the leakage, the soap solution is only used in that specific area of the tank. The soap solution bubble test method is very less expensive as compared to other methods of leakage detection. However, if the operator does not aware about approximate area of leakage; then it can be more expensive due to more labor costs. Exact location of leakage can be found out in least time by increasing the gas pressure. However, for comgerment of operator, the pressure must be constricted to 1700 kPa. There are some of the limitations while using the method of soap solution bubble test. The limitations are as follows:

- The surface, on which soap solution is sprayed, should be inoffensive and easily accessible.
- It is impossible to use soap solution and spy foe bobble on bottom part large pipes or bottom surface of the broad heat exchanger.

C. Vacuum chamber inside-out leak testing

This is the most complex system of leak detection, but it is theoretically suitable to find very small leakages, using the proper tracer gas. In this method the equipment is composed of one or more vacuity chambers, large enough to house the unit to be tested. The chamber is aggultinated to a vacuity pumping group furnished with the tracer gas detector, for migration of chamber and gas detection. A second vacuity group is required to deplete the unit under test before filling it with gas. The testing apparatus is completed by a tracer gas-filling device. The tank to be tested is kept into vacuity chamber and connected with service hoses. Then the vacuity chamber and the tank are evacuated. During chamber migration, the part is pressurized with the tracer gas and after a stabilization time, the detector is linked to the vacuity line so as to detect the flow of tracer gas through a leakage and drawn in by the pumping group. Leakage is pinpointed with the use of this sequence of operations. It is nothing but a 'go' or 'no-go' test, to finding the location of leakage requires other methods.

There are some of the limitations while using the method of vacuum chamber inside-outside leakage test. The limitations are as follows:

- Depending on the vacuity chamber dimensions, the evacuation group could call for a high pumping speed. Some gas detectors require magazine maintenance to assurer proper performance, since they are complex systems composed of vacuity pumps, a mass spectrometer and vacuity fittings.
- The cost of the tracer gas may be luminous besides and, in case of a particularly costly gas, the use of a suitable gas recovery and reclaim system should be considered, further boosting the overall costs as well as the system entanglement.
- The exact location of the leakage cannot be pinpointed by using this leakage testing method. It detects total system leakage only. For pinpointing the leakage, there is required to use another technique of leakage detection.

9. CONCLUSIONS

From the study of leakage detection of fuel tank and vacuum tank it is concluded that,

A. Testing of leakage of fuel tank and vacuum tank after seam weld is cheaper than testing it on final stage which saves the manufacturing cost.

B. System shows location of leakage on tanks after seam weld. This system runs effectively.

C. The rate of leakage can be reduced by analyzing the location of leakages on most of the tanks manufactured.

D. It requires very low space. This system is less expensive at initial as well as less running cost.

E. It does not require an external energy sources to run the system. Therefore maintenance cost is also very low.

Overall, this system is very beneficial for manufacturers of fuel tank and vacuum tank.

ACKNOWLEDGEMENT

It is a great sense of satisfaction that we represent our real venture on practical computing in the form of this study. At first we would like to thank Mr. Sachin S. Morti (Guide/Lecturer, Department of Mechanical Engineering), for his time to time tips and help in every stage of this work. Also we would like to thank Mr. Rajwardhan Jagdale sir (Managing partner, Pushparaj Engineers, Gokul Shirgaon

MIDC Kolhapur) for giving this opportunity in the form of this project work. We wish to express our gratitude to all the teachers for their technical and moral support which was desperately needed during the starting of this study.

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