International Journal of Engineering Research and General Science Volume 2, Issue 3, April-May 2014
ISSN 2091-2730

Review Paper on Leak Detection

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ABSTRACT - The word "leak" and "leakage" appears in the field of vessels hermetical closing and do not confront only with vacuum technologies but also engineering working with high pressure. Practically it is impossible to build a completely leak proof vacuum system. There are multiple of applications in the industry, where it is necessary to test a hollow fabricated body for fluid leakage.Number of leak testing method has been proposed for testing of hollow components.This paper gives a review of various methods of leak detection of vacuum system.

Keywords: pressure decay, water bubble test, vacuum, helium leak detectors, Helium mass spectrometer, Radioisotope method, Dye penetrate method, fluid transient model.

INTRODUCTION

All sealed systems leak. Every pressure system has leaks because "imperfection" exists at every joint fitting, seam or weld. These "imperfection" may be too small to detect even with the best of leak detection instruments but given time, vibration, temperature and environmental stress, these "imperfection" become larger, detectable leaks.

A LEAK IS NOT...Some arbitrary reading on a meter. Gas escapes at different times and at different rates. In fact, some leaks cannot be detected at the time of the test. Leaks may plug, and then re-open under uncommon conditions.

A LEAK IS...A physical path or hole, usually of irregular dimensions. The leak may be the tail end of a weld fracture, a speck of dirt on a gasket or a microgroove between fittings.

Production leak testing is implemented to verify the integrity of a manufactured part. It can involve 100% testing or sample inspection. The goal of production leak testing is to eliminate "leaky" parts from getting to the customer. Because manufacturing processes and materials are not "perfect," leak testing is often implemented as a final inspection step.In some cases, leak testing is mandated by a regulation or industry specification. For example, in order to reduce hydrocarbon emissions from automobiles, auto makers are now designing and leak testing fuel components to tighter specifications required by the EPA. Also, the nuclear industry enforces regulations and leak test specifications on components such as valves used in nuclear facilities. Whether mandated by regulation or implemented to insure product function and customer satisfaction, leak testing is commonly performed on manufactured parts in many industries including automotive, medical, packaging, appliance, electrical, aerospace, and other general industries.

One of the greatest challenges in production leak testing is often correlating an unacceptable leaking part in use by thecustomer (in the field) with a leak test on a production line. For example, the design specification of a water pump may require that no water leaks externally from the pump under specified pressure conditions. However, in production it may be desirable to leak test the part with air. It is intuitive to assume that air will leak more readily through a defect than water. One cannot simply state "no leakage" or even "no leakage using an air pressure decay test". This would result in an unreasonably tight test specification resulting in an expensive test process and potential scrap of parts that may perform acceptably in the field. Therefore, one must set a limit using an air leak test method that correlates to a water leak. Establishing the proper leak rate reject limit is critical to insure part performance and to minimize unnecessary scrap in the manufacturing process. Determining the leak rate specification for a test part can be a significant challenge. Having a clear and detailed understanding of the part and its application is necessary in order to establish the leak rate specification. Even then, many specifications are estimates and often require the use of safety factors.The automotive industry has

implemented a leak rate specification for fuel handling components that species a maximum allowable theoretical leak diameter. The advantage of this way of expressing the leak rate limit is that it gives the part manufacturer significant leeway in designing the appropriate leak test. The challenge, however, is correlating the theoretical leak diameter to an actual leak rate. Users of these specifications must understand the theoretical relationships between leak hole geometry and gas flow and all users must implement these relationships consistently. A second option is to set the leak rate limit of the specific test using a leak orifice or channel that has been manufactured and dimensionally calibrated to the geometry (diameter and path length) required by the specification..

[1] N. Hilleret

In this paper, various methods of leak detection are explained and also gives information about instruments used for leak detection purpose. In the case of vacuum the vessels, it is necessary to check that tightness of vessel by means of guarantee of leak proof before installation. Depending upon the size of leak, method of leak detection is selected from various methods. All methods based on the variation of a physical property measured along the vacuum vessel. For large leakage gas flow can generate mechanical effects but for small size leakage finer method required.

The various methods of leak detection such as tracer gas, helium leak detectors, direct flow method, counter flow method, detector probe method (sniffer) as well as characteristics of detector, the use ofthe detector is described in this paper.

[2] K Zapfe

This paper gives an introduction about leak detection of vacuum system. Helium leak detector and its different applications along with various leak detection methods are described. Helium leak detector is most widely used method in the industries. It is important to specify an acceptable leak rate for each vacuum system.

Leak detection plays an important role in manufacturing. After manufacturing of the vacuum vessel is must be proven than the tightness specifications are fulfilled. Further checks are necessary during as well as after assembly and installation to locate possible leaks. For that various methods like mechanical effects, pressure increase, tracer gas, helium leak detector, direct flow method, counter flow method are introduced in this paper. Leakage rate, types of leaks, practical experience and examples of leak detection, different application of helium leak detector are explained in this paper.

[3] Andrej Pregeli et al

In the industries there is a need to manufacture detect free hermetically closed elements.

In this paper, discussed about leak detection methods and defining the sizes of leakage. In this paper describes the maximum acceptable leak rate. According to that the product should be accepted or rejected. Various methods of leak detection i.e. Pressure change method, overpressure method, Halogen leak detector, Dye penetrant method, Acoustical leak detection, Radioisotope method, mass spectrometer as leak detector, Helium mass spectrometer are described in this paper.

[4] Donald T. Soncrant

In this paper, describes the method to improve speed of testing of hollow particles of fluid leakage consist of closed charged valve, open charged valve, compressor and hollow workpiece. Time delay valve is used to regulate pressurized air supply. When time delay valve cut off, test valve get actuated it measure flow rate through hollow component, if workpiece is acceptable it turns ON ‘accept’ light. If the flow rate exceeds predetermined value, it turns ON ‘reject’ light.

This leakage testing method is used in the industry for testing hollow body for fluid leakage. Electronically actuated valve and relays used to conduct test in a sequence. Here, no special voltage reduction, filtering and voltage regulating devices are required. Operation is independent of voltage variation. This method is more reliable and less complex method. Hence used in the industry for testing of hollow components.

[5] Joachim W. Pauly

In this paper, vessel such as submarine is selected for testing of leakage of air, by establishing pressure level and test flow to the vessel. For determining the leakage of air in vessel, difference in pressure in the vessel is monitored, and determining whether the leakage rate from the vessel exceeds a predetermined rate by relating the test flow rate to its effect on the pressure level in the vessel.

In 1^{st} operation, variable test flow is delivered to the vessel and adjusted such that as needed to maintain pressure in the vessel at test level, rate of this flow is measured when stabilized and measured values are converted into standard units. In 2^{nd}operation, constant flow rate is delivered to the vessel which is equivalent to leakage in vessel and effect of pressure difference in vessel indicates the relation between leakage rate and test flow rate.

[6] Sami Elaoud et al

This paper presents a technique for detection and location of leakages in a single pipe by means of transient analysis of the hydrogen natural gas mixture flows. In this technique transient pressure waves used which are initiated by the sudden closure of a downstream shut off valves. The purpose of this paper is to present a numerical procedure utilizing transient state pressure and a discharge analysis to detect leakage in a piping system of a hydrogen and natural gas mixture. The presence of leak in pipe partially reflects transient pressure waves at allows for location of the leak. To determine the leak location, the mathematical formulation has been solved by the characteristics methods of specified time intervals.

[7] S.Hiroki[ax]et al

In this paper Krypton (Kr) is used as a water soluble tracer for detecting water leak in a fusion reactor. This method was targeted for applying to the international thermonuclear experimental reactor and 10^{-3} Pa m^3/s order of water leak valves where fabricated and connected to the water loop circuit. Water dissolve in a Krya is detected by the Quadruple mass spectrometer (QMS) Imposed leak detection method for the water channels is proposed where the leak detection can be done with fully circuiting cooling water. Water soluble tracer gas is effused into the vacuums vessel through a water leak passage.

[8] T. Kiuchi

This paper describes a method for detection of leak and location of leak by applying fluid transient model. In this testing of real time pipeline and resulting conclusion is obtained by using fluid transient model. This method considered flow rate measurement and pressure measurement. Because of this, the method gives more accurate detection of leak and position of leak than conventional methods, but in this method assumption is made that flow inside the pipeline is quasi steady state flow. The influence of method accuracy is examined, and the result shows the advantage of method compared to conventional methods.

[9]John Mushford

In this paper, presents a method of investigation of data obtained by collection of all data monitoring from pressure sensors inthe pipe network, which gives not only location but also size ofthe leak. In this paper use of support vector machine which acts as a pattern recognizer, which gives location and size of leak with a high degree of accuracy, and the support vector machine is trained and tested on data obtained from EPANET data hydraulic system.

[10] Guizeng Wang et al

In this paper, a new leak detection method based on autoregressive modelling proposed. Testing of pipeline model and resulting concussion is obtained by using Kullback information. Kullback information is very in time sequence analysis. A leak above 0.5% can be easily detected by Kullback information. This process does not require flow rate measurement. Four pressure measurements, two at each end of pipe is required.

CONCLUSION

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. A careful and thoughtful evaluation at each of these steps, combined with the selection of high quality leak test hardware, will result in a cost effective, high performance, and reliable production leak test.

This project has described methods for the finding the leaks and there location in a hollow casting and other components. Pressure difference obtained by the pressure decay test will give confirmation about presence of leaks, and water immersion test will give us location of leaks. These two methods are less time consuming and give the quick results with high accuracy. The end result is stricter quality controls for leak testing.

REFERENCES:

[1]N.Hilleret, Leak detection, CERN, Geneva, Switzerland

[2] K, Zapfe, Leak detection, Hamburg.Germany

[3] Andrej pregelj et al, Leak detection methods and defining sizes of leaks, april1997

[4] Donald T.Soncrant,Fluidic type leak testing machine

[5] Joachim W. Pauly, Method and apparatus for testing leakage rate, May07/1974

[6] Sami Elaoud et al, Leak detection of hydrogen-natural gas mixture in pipe using the characteristics methods of specified time interval, 21 June 2010

[7] S.Hiroki, Development of water leak detection method in fusion reactor using water-soluble gas, 18 June 2007

[8] T.Kiuchi, A leak localization method of pipeline by means of fluid transient model

[9] John Mashford et al, An approach to leak detection in pipe network using analysis of monitored pressure values by support vector machine.

[10]Guizengwang et al,Leak detection for transport pipelines based on autoregressive modelling.

[11] William A.McAdams et al, Leakage testing method, Aug 12, 1958

[12] Percy Gray, Jefferson, Lined tank and method of construction and leakage testing the same.