

Leakage Testing Machine

A. N. Gowardipe¹, Ajay Deshmukh², Prashant Dimble³, Akash Deshmukh⁴, Nandkishor Garje⁵

¹Prof. Of the Department, Department of Mechanical Engineering, D Y Patil School of Engineering and Technology, Pune, India

^{2,3,4,5}U G Student, Department of Mechanical Engineering, D Y Patil School of Engineering and Technology, Pune, India

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: leak testing machine, casting component, crack, dry leak test, location of leakage

1. INTRODUCTION

The testing machines differ considerably in procedure, purpose, nature and even terminology in different branches of machine building. Tests are made in factories and while the machines is in operation. The purpose of the trial determines whether acceptance tests, check tests or research tests are made. All branches of machine building test models or full-scale machines of new designs and random samples from assembly lines; they also test machines to continue research.

1.1 NECESSITY

In Industries, components and systems are tested to ensure that there are no leakages. As some components are used for high precision application so they must able to sustain their accuracy at that level. This Leak Testing Machine it is specially designed for leak testing of a particular component. The Three Basic Functions of any Leak Testing Machine are detection of leakage, measurement of leak rate, leakage location.

1.2 Types of Testing

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.

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.

2. PROBLEM STATEMENT

There are certain problems which are associated with the parts of the components, i.e. crack, dent, and instructions. From which some of the components which will work against high pressure must be leak tested first.

Leak Testing is a crucial quality assurance process- leaky parts that slip through the cracks lead to problems down the line or warranty claims. But company often lacks the expertise and the tools to ensure a consistently reliable seal between the part and test station. This can skew test results, allow faulty parts to pass and fail perfectly good once and erode confidence in the leak test system even if it isn't the source of the problem.

3. OBJECTIVE

To leak test an aluminium casting component by designing and manufacturing leak testing machine,

- 1) Determining if there is leakage or not
- 2) Measurement of leak rate.
- 3) Leakage location.

There are many methods and types of test equipment for solving these problems, but unfortunately there is no single technique that fits every situation. 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.

In this project we design a hydraulic circuit for the leakage testing machine. For the designing of the hydraulic circuit we used the various components like hydraulic power pack unit, Solenoid operated 4/3 Direction Control Valve, Electric Motor, Pump, Tank and Double acting cylinder.

In this project we also design a pneumatic circuit for the leakage testing machine. For the designing of pneumatic circuit, we used the various components like pneumatic unit and various pneumatic components like air dryer, FRL unit, air compressor, direction control valves.

4. WORKING OF MACHINE

In every industry the main problem is leakage found in the casting component, forged component, welded component. Due to this various 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 two methods namely dry testing & wet testing for the detection of leakages in the component or equipment.

In air or dry testing, 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.

In wet testing 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. Then we dip the 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 both pneumatic and hydraulic circuit.

For checking the loss of air in the component we use the COSMO LS-R700 leak tester in this tester calculate air which received after passing through the component. After that we can tell component is ok or faulty.

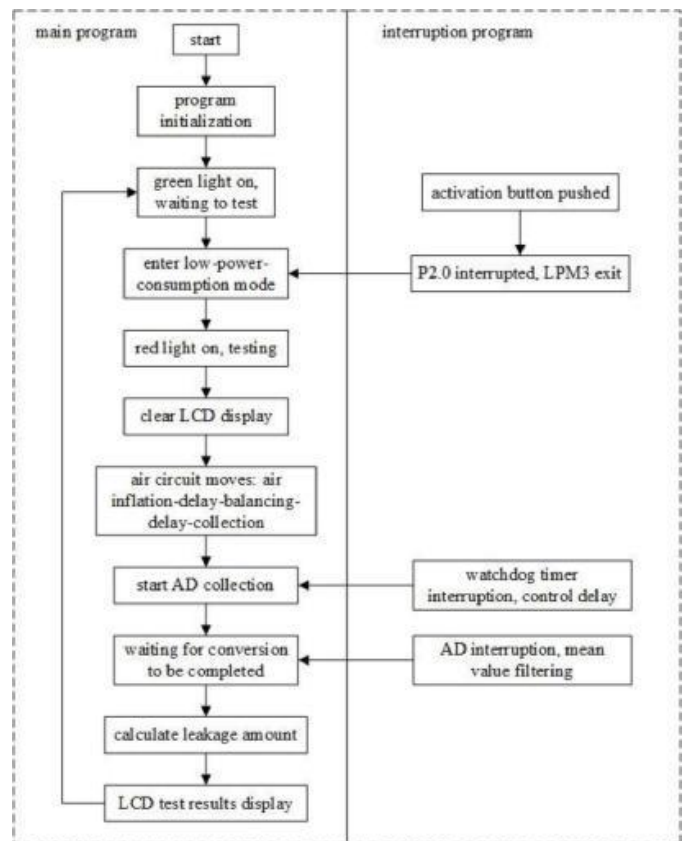


Fig -1 Flow diagram for leak testing machine

5. PNEUMATIC UNIT

In pneumatic unit we used the various components such as Compressor, FRL unit, Air dryer, Direction Control valves, etc. The function of the pneumatic unit is to take the air from the atmosphere and used these pressurized airs for the checking of leakage in the component. After that air is blown down to the atmosphere.

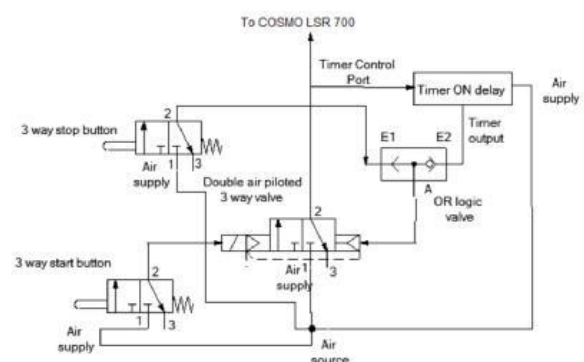


Fig -2 Pneumatic circuit

Table -1 Function of component

Sr. no.	Component Name	Description
1	Start button (push type)	For switching on the timer circuit and beginning the actuation
2	Double Air Piloted Valve 3 way	To redirect the air to the timer and the main piston
3	Timer	To hold on the piston actuated by using preset delay
4	OR logic valve	To help functioning of stop button along with that of timer output
5	Stop button (push type)	To stop the circuit immediately when the process is going on (in case of an emergency)

PNUMATIC COMPONENTS USED FOR MACHINE

5.1 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.

5.2 Air dryer

A compressed air dryer is used for removing water vapor from compressed air. Compressed air dryers are commonly found in a wide range of industrial and commercial facilities.

The process of air compression concentrates atmospheric contaminants, including water vapor. This raises the dew point of the compressed air relative to free atmospheric air and leads to condensation within pipes as the compressed air cools downstream of the compressor.

Excessive water in compressed air, in either the liquid or vapor phase, can cause a variety of operational problems for users of compressed air. These include freezing of outdoor air lines, corrosion in piping and equipment, malfunctioning of pneumatic process control instruments, fouling of processes and products, and more.

5.3 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 air line 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.

5.4 Air Leak Tester COSMO LSR-700

We used this leak tester for testing the component. In this leak tester air calculate after passing through the component. After that we can tell component is ok or faulty. Also we can find leak rate in this leak tester.

6. WORKING OF LEAK TESTER

6.1 LEAK RATE Q:

$$Q = Ve \times \frac{\Delta P}{1.013 \times 10^5} \times \frac{60}{T}$$

Q: Leak rate (mL/min) ΔP: Differential pressure (Pa) Ve: Volume equivalent (mL) T: Detection time(s)

Example: A differential pressure of 15 Pa was measured when the volume equivalent was 800 mL and the detection time was 3 seconds. What is the leak rate under these conditions?

Formula $800 \times \frac{15}{1.013 \times 10^5} \times \frac{60}{3} \approx 2.3 \text{ (mL/min)}$

The differential pressure which occurs due to leaks is inversely proportional to the volume equivalent. [Example]

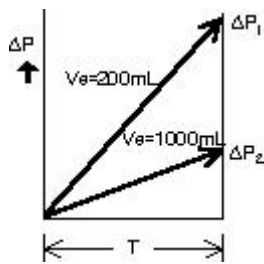
When the ratio of the volume equivalent is 1 to 5, the differential pressure at the same leak rate would be 5 to 1.

Q: 5mL/min

T: 2s

ΔP1 = 85 Pa when Ve = 200 mL

ΔP2 = 17 Pa when Ve = 1000 mL



<Reference> Pressure and characteristics of gases

Standard atmospheric pressure : 1 atm

$$\left\{ \begin{array}{l} = 1.01325 \times 10^5 \text{ Pa} \\ = 1.03323 \text{ kg/cm}^2 \text{ A} \\ = 1.03 \times 10^4 \text{ mmH}_2\text{O} \\ = 760 \text{ mmHg} \end{array} \right.$$

2) Units of pressure 1 bar = 0.1 MPa = 1.01972 kg/cm²,
1 Pa = 1 N/m², 1 Torr = 1 mmHg

3) Equation of state of gases

There is constant relationship among three quantities of pressure, volumetric capacity and temperature of gases. Once two of them are determined, the other is consequently determined. The equation describing the relationship among these three quantities is called an equation of state, consisting of the "combined gas law."

$$PV = GRT \dots\dots\dots (1)$$

Initial state Final state

$$\frac{P_1 \cdot V_1}{T_1} = \frac{P_2 \cdot V_2}{T_2}$$

When (V1, P1, T1) → (V2, P2, T2)

If the temperature is constant T1 = T2, P1·V1 = P2·V2 (2)

If the volumetric capacity is constant V1 = V2, P1 / T1 = P2 / T2 (3)

- P: Absolute pressure
- V: Volumetric capacity
- G: Weight of gas
- T: Absolute temperature
- R: Gas constant

2) SETTING THE TEST TIME

(1) Detection time setting

The differential pressure value and detection time (T3) corresponding to the leak standard value Q are found and set using the volume equivalent Ve. Setting of a detection time of 2 to 10 seconds and a differential pressure value ΔP in the range of ±10 to 100 Pa are generally suitable.

$$\Delta P = \frac{Q}{V_e} \times \frac{T}{60} \times 1.013 \times 10^5$$

Q: Leak rate (mL/min)

Ve: Volume equivalent (mL)

ΔP: Differential pressure (Pa)

T: Detection time (s)

If using a leak tester with the leak rate direct-read display feature, there is no ne differential pressure.

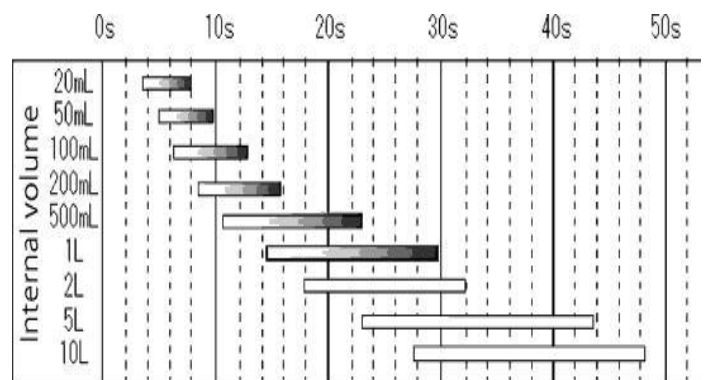


Fig -3 Time vs. volume graph

The above graph does not include detection time.

Time can also change depending on the precision required.

Low pressure <- Test pressure -> High pressure



Low pressure (10–100kPa) High pressure (100–600kPa)

7. ADVANTAGES

1. Components are not subjected to compressive loads, as flange to flange type clamping system is adopted.
2. Easy loading of component and pneumatic clamping system for sealing between dummy tank and body.
3. This technique offers leakage detection accuracy in the 10-3 Pa.m³/s range.
4. It is especially useful in high volume applications, and leak detection and location is very economical.

8. 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.
3. Used in Aeronautical industry.

9. CONCLUSION

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.

REFERENCES

- [1] S. B. Kakuste, et al. "Review Paper on Leak Detection", International Journal of Engineering Research and General Science Volume 2, Issue 3, April-May 2014.
- [2] N. Hilleret "Leak Detection" CERN, Geneva, Switzerland 203-2012.
- [3] Weber "Advanced Leak Test Methods", Assembly Magazine, pg. 14-15, 2001.
- [4] Donald T. Soncrant "Fluidic Type Leak Testing Machine."
- [5] William A. Mc Adams et al, "Leakage Testing Method", Aug 12, 1958.