DESIGN AND DEVELOPMENT OF VOLUMETRIC EXPANSION AND HOT IMPULSE TEST SYSTEM FOR HYDRAULIC BRAKE HOSE

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Abstract : Brake hose means a flexible conduit manufactured for use in a brake system to transmit or contain the fluid pressure or vacuum used to apply force to a vehicle's brakes. Brake hose assembly means a brake hose, with or without armor, equipped with end fittings for use in a brake system. Hydraulic hose assemblies are used in almost all machinery and plants applying hydraulically controlled component groups , in particular, where rigid pipes for power transmission cannot be used. Due to defective binding, ageing, wear, damage, load and for other reasons, hydraulic hose assemblies represent a various hazard. Therefore it is very important to check hydraulic hose assemblies at regular intervals of time and to replacing them in case of failure or aging. In this work, a test rig is designed and developed for volumetric exapansion and hot impulse test for hydraulic brake hose according to specifications of SAE J1401 and SAE J1833 respectively. In this test setup pressure is applied to a hose by using master cylinder and hydraulic power pack assembly and to control overall process programmable logic control with HMI display is used.

Index Terms: *Hydraulic hose , volumetric expansion , SAE, Hot impulse*.

I. INTRODUCTION

In the 1960s, failure in hydraulic system was generally considered as a result of overpressure. After that the ISO suggests a burst pressure test for hydraulic hose.ISO claims that it is necessary for hoses to have the ability sustain pressure four time of working pressure in a short time (ISO 2009). After that American Society of Automotive Engineers (SAE) suggests fatigue test. A survey carried out by British Ministry of Defense, into more than 100 defects of hydraulic hose indicated that mistreatment was the primary reason for hydraulic component failure, which leads to the reform of the hydraulic component tests. Later the SAE and ISO proposed the different hydraulic hose tests to reduce the probability of accidents [1]. In this one of the tests is volumetric expansion test. The volumetric expansion test is designed to measure the volumetric expansion of the hydraulic brake hose by fluid displacement when subjected to internal pressure. The second test is hot impulse test. This test to verify the structural integrity of hydraulic brake hose. It is designed to simulate the effects of environmental aging and braking pressure on brake hose assemblies. The test is a guide for hose designers and users in determining brake hose performance heat and pressure. .

The focus of this paper is on the design and development of a machine which can conduct this tests.

II. DESIGN AND DEVELOPMENT OF TEST RIGS

Volumetric expansion test

The This test setup designed to take test according to specifications of SAE J1401 JUN 2003.First this test concerns 105 bar pressure applied to a brake hose for 10 seconds . Second the pressure is released and then the amount of brake fluid leaked out of the brake hose is measured. . To conduct this test, isometric view of test rig is as shown in figure 1..

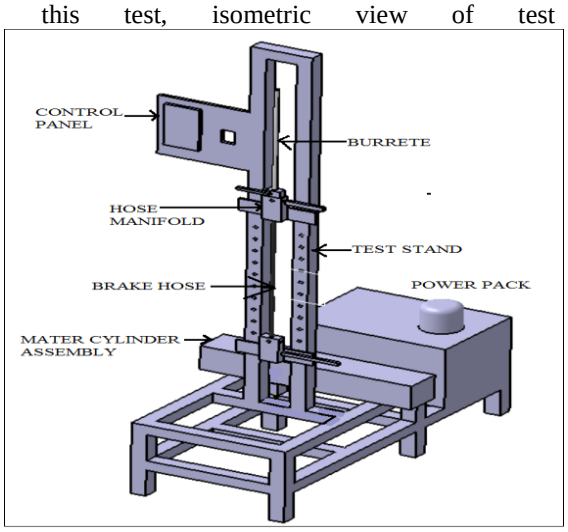

Fig- 1: Isometric view of volumetric expansion test rig

This test rig consists hydraulic power pack, hydraulic cylinder ,master cylinder for pressure generation, 2 way lead ball valves,motor starter and pressure indicator.In this fluid pressure is transfer from power pack to master cylinder assembly and from master cylinder assembly to inlet of the hose. The power pack consists radial piston pump which is capable of generating pressure of 200 bar at 2 LPM flow.The master cylinder and hydraulic cylinder having diameter 25mm and 40 mm respectively. The intensity of pressure can be controlled by pressure regulator according to customer requirement.The brake hose is mounted in between manifolds and pressure is applied by using brake fluid for 10 seconds. After pressure is released amount of volumetric expansion is calculated by measuring liquid level in burette.The figure 2 and Figure 3 shows the volumetric expansion test procedure.

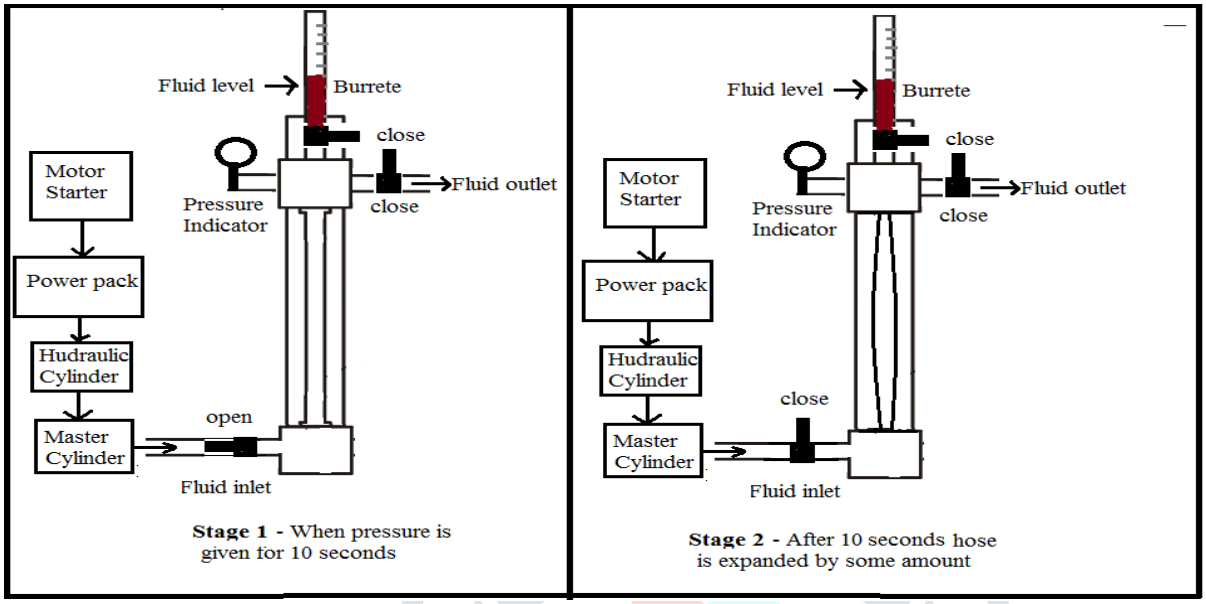

Fig-2: volumetric expansion test procedure

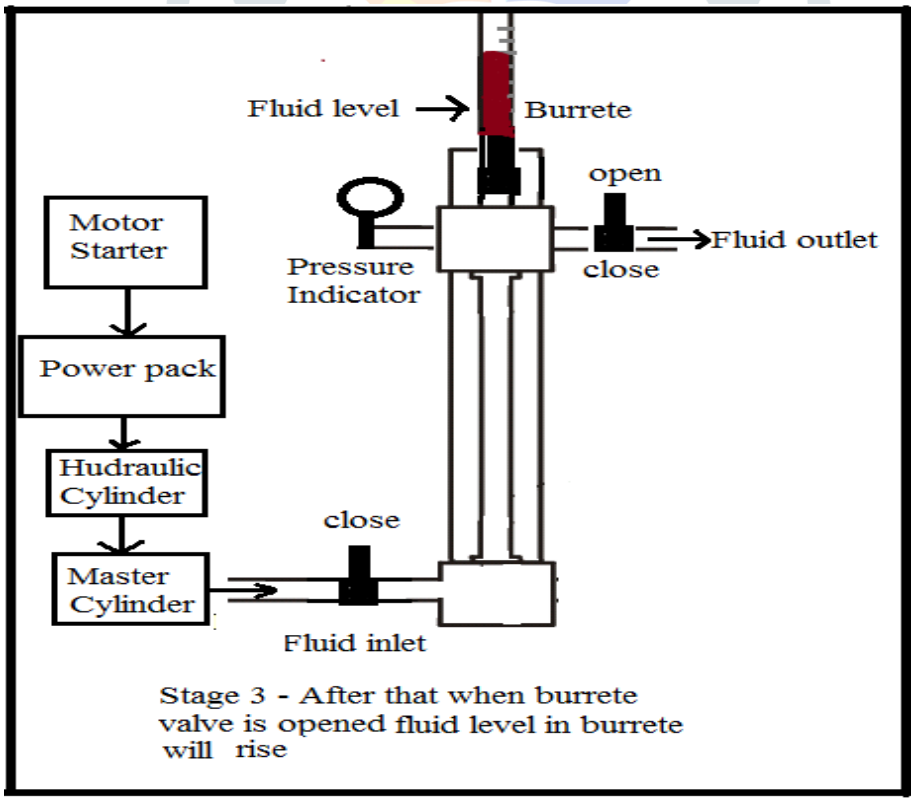

Fig-2.1: volumetric expansion test procedure

Fig- 3: volumetric expansion test rig

Hot impulse test

This test setup designed to take test according to specifications of SAE J1833 NOV88. In this test brake hose is placed in an oven under a controlled temperature and it is subjected to a pressure over 1 minute and the next minute without pressure. This is performed 150 times. Figure 4 shows pressure vs time graph of hot impulse test.

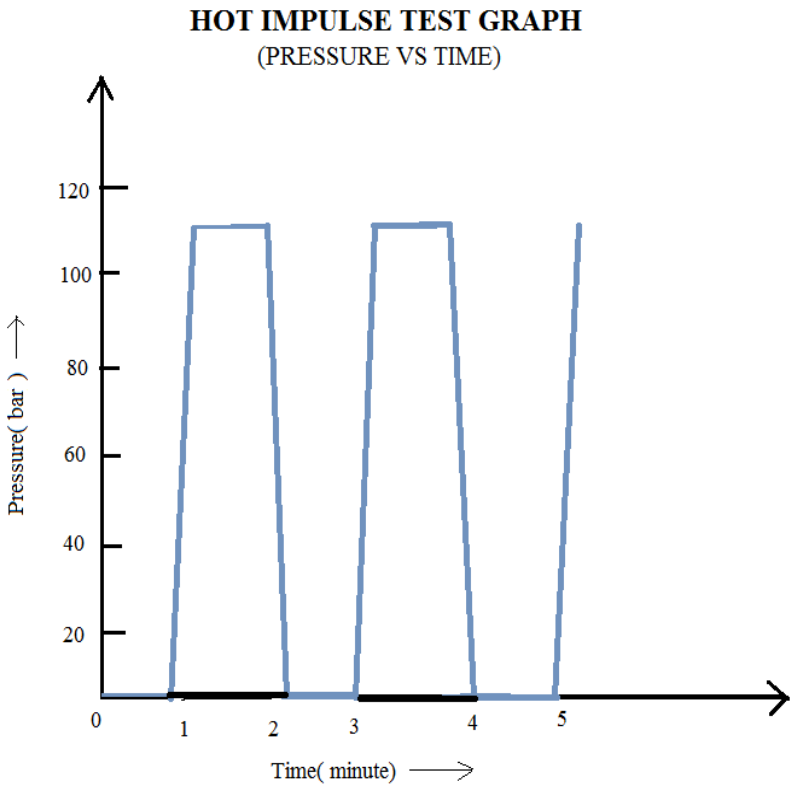

Fig- 4: Pressure vs time graph of hot impulse test

Design and Developemnent of Hot impulse Test rig

The figure 5 below shows schematic of hot impulse test setup.

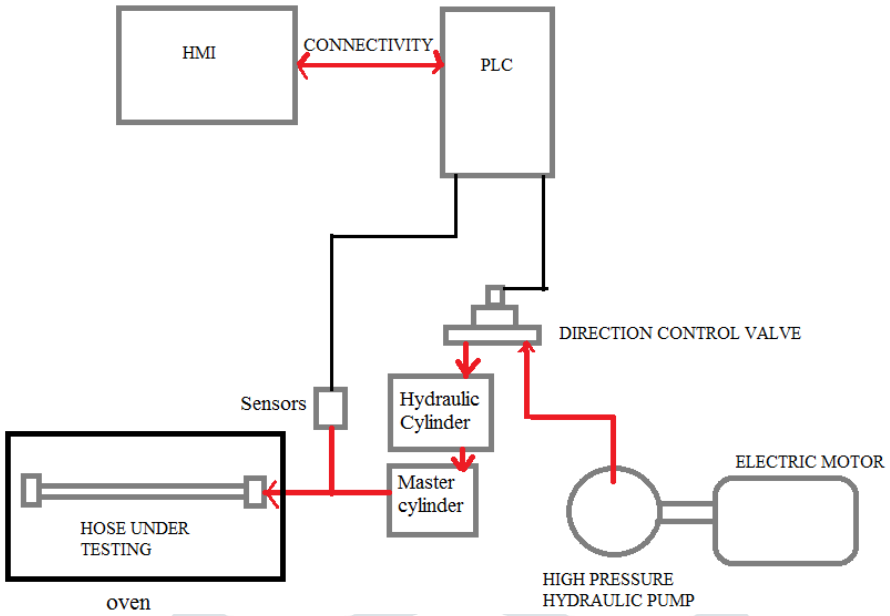

fig- 5: Schematic of hot impulse test setup

The figure 6 below shows the isometric view of the front side of hot impulse test rig.

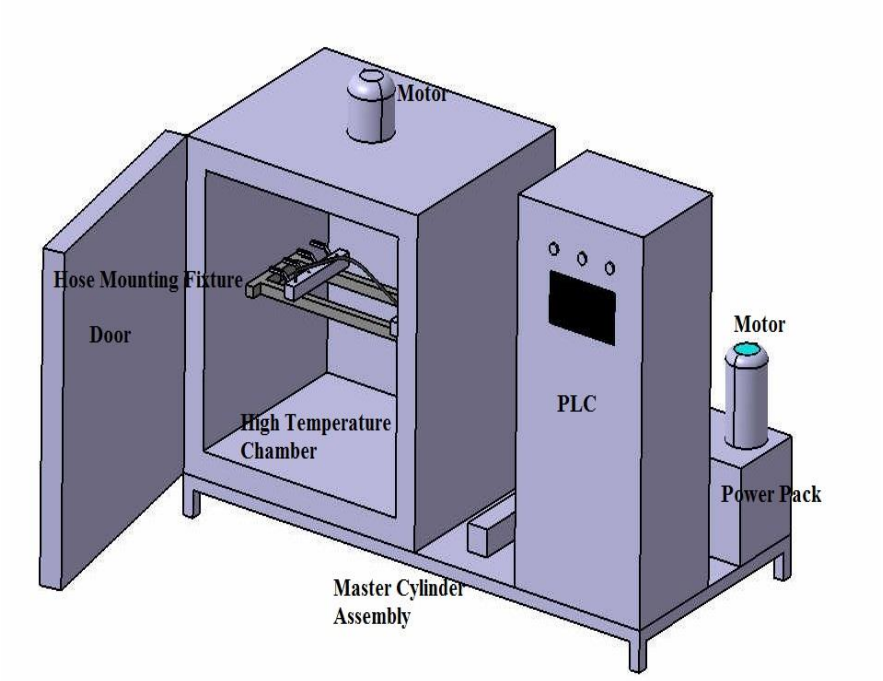

Fig- 6: Isometric view(front side) of hot impulse test rig.

This test rig consists hot temperature chamber, hose mounting fixture, hydraulic power pack, hydraulic cylinder ,master cylinder for pressure generation, 2 way lead ball valves ,PLC (Mistubishi NG 16DN) with HMI , silicon rubber ,glass wool for insulation and pressure indicator, temperature sensor PT100, motors and 4 resistance heater each having 1.5 Kw-hr capacity. In this fluid pressure is transfer from power pack to master cylinder assembly and from master cylinder assembly to inlet of the hose. The power pack consists radial piston pump which is capable of generating pressure of 200 bar at 2 LPM flow.The master cylinder and hydraulic cylinder having diameter 25mm and 40 mm respectively. The intensity of pressure can be controlled by pressure regulator according to customer requirement.The brake hose is mounted in between manifolds and pressure is applied by using brake fluid. This test setup has capability to take tests of 4 hose at a single time.The PLC has a provision to control temperature ,number of cycle also limit switch is mounted at door of the hot chamber for safety purpose.

Fig- 7: Hot impulse test setup up (front view)

III. Experimental results

Volumetric expansion test rig

After completion of the manufacturing a hose having 3 mm internal diameter have been tested on volumetric expansion test rig at a pressure of 70 bar ,100 bar and at 185 bar.

Table -1 Volumetric expansion test results

Pressure (In bar)	Volumetric Expansion . (In cm^3/m)
70	0.95
100	1.23
185	1.78

Hot impulse test rig

The figure 8 below shows pressure vs time graph optained at 100 bar pressure on HMI of PLC.

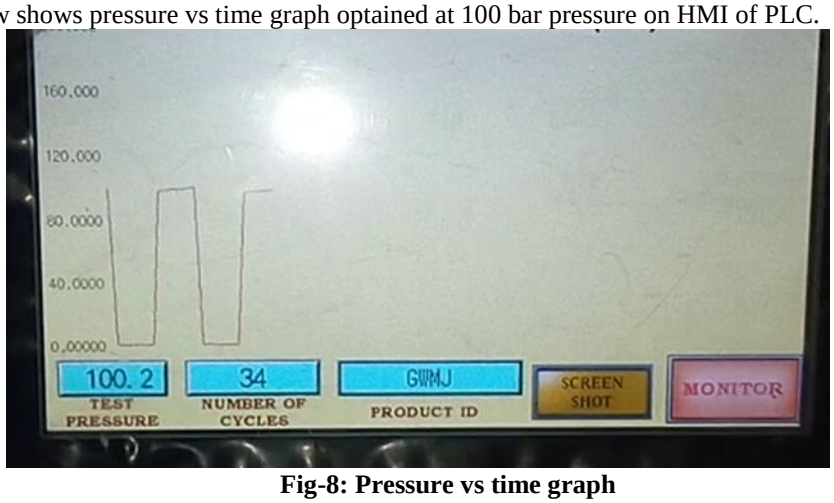

Fig-8: Pressure vs time graph

The figure 9 below shows HMI screenshot during test at 103 bar pressure and 99 °C.

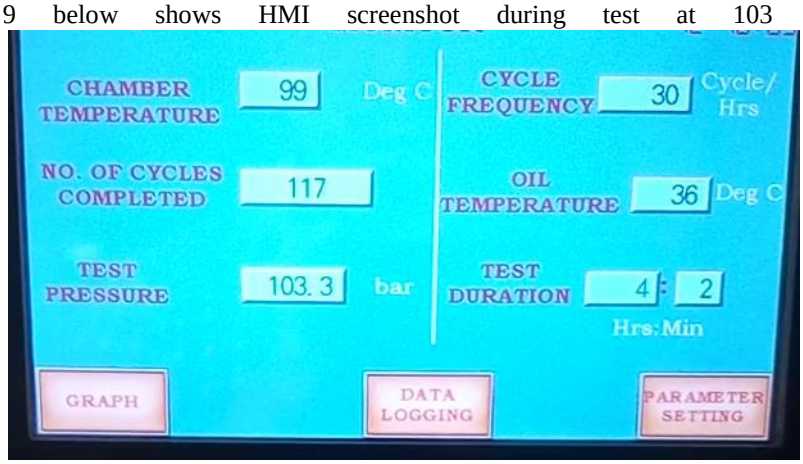

Fig-9: Test at 103 bar pressure and 99°C

The figure 10 below shows HMI screenshot during test at 103 bar pressure and 141 °C. .

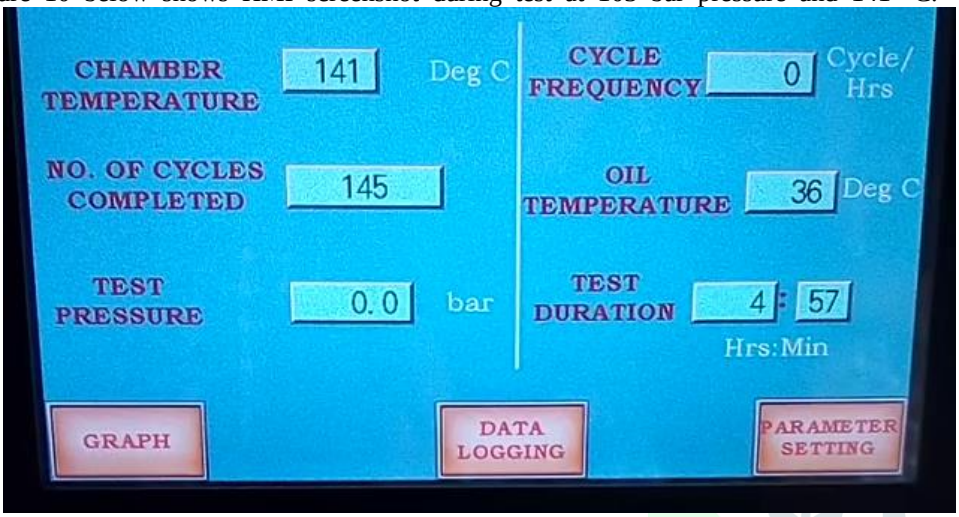

Fig-10: Test at 103 bar pressure and 141 °C

IV. Conclusion

Volumetric expansion test rig

It is concluded after taking tests that this volumetric expansion test rig can take tests according to specifications of SAE J1401.It is manually operated test rig so we can apply pressure for more time according to designer requirement .The intensity of pressure can be reduced or increased by using pressure regulator. This system consist master cylinder which is made by non metallic material because of that it can handle corrosive break fluid by using this we applied pressure. There is a provision in this model which consist extra valve which is used for removal of air from system which makes this system more efficient. Also we can mount two types of hose in this system. Burette which we have used for measurement of fluid level is designed to observe even little displacement of fluid and also maginifed glass is provided with it for better accuracy of reading. As we can see in figure 5.20 arrangement of power pack and master cylinder assembly it is easy for maintainance also.

Hot impulse test rig

It is concluded after taking tests that this hot impulse test rig can take tests according to specifications of SAE J1833. It is PLC operated system and it has provision for adjustment of pressure, tempreture and number of cycles. It has capacity to take tests at more than 200 bar and it can attain temperature of 150°C in less than 2 minute. Also in this test setup we can test 4 hoses at a same time and it can test 2 types of hose. A limit switch is also provided at door for safety purpose. Unless and until the door is closed process won't start.

Future scope

By increasing the pressure generation capacity it can be used for different hose test. Also by changing manifolds design it is possible to test a hose of different internal diameter and it also facilitate to take a test on more than 4 hose at single time.In this setup pressure is given to the hose by using brake fluid which is corrosive in nature due to this hydraulic power pack and master cylinder assembly is used but if different types of fluid is used for pressure generation purpose and if it is of non corrosive in nature then other simple setups can be used for power generation.

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