International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Design and Development of High Horsepower Lube Oil Relief Valve Test Rig

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Abstract: ***A test rig is a mechanical device used to assess and test the capabilities and performance of industrial components. The high horsepower lube oil valve testing machine, often known as a rig, is a machine created particularly for High Horse Power valves. These valves are part of the locomotive's lubrication oil system, which we have tested. By directing a part of the oil to the engine sump, the relief valve protects the system from harm caused by high pressure. The creation of a lubricating oil High Horse Power relief valve test equipment to test relief valves is described in this study. There was a need for a test bench in the Diesel Loco Shed to ensure the safety of both the engine and the operators.***

Keywords: Relief valve, High horsepower, lube oil

1. Introduction

The Test-rig consists of a Regulating valve, Pressure gauge, motor and Relief valve. In addition to thesefour major components, the test-rig also consists of several other components such as hydraulic hose pipe, gate valve, filter, lube oil tank, etc.

1.1 Problem Statement

Because there is no such machine in Mumbai for testing relief valves, Diesel Loco Shed would benefit this type of fabrication. They may test the High Horse Power valve in their shed and determine whether it is ready for usage on a locomotive engine. Also, if a valve has not been used in a long time, it may be tested, and if it is in good shape, there is no need to purchase a new valve. They also save time since they can test right away.

2. Methodology

2.1 Flow Chart of Methodology

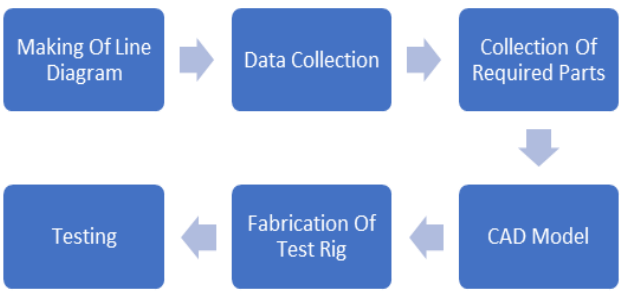

Figure 2.1: Flow chart of Methodology

2.2 Methodology used in the work

Essentially, a methodology is a collection of methods, practices, processes, techniques, procedures, and rules. In project management, methodologies are specific, strict, and usually contain a series of steps and activities for each phase of the project's life cycle. They're defined approaches that show us exactly what steps to take next, the motivation behind each step, and how a project stage should be performed.

Basic Information
This paper discusses about how to usedata & identify the problems from field. By studying the process of previously available system that help in maximizing the output by minimizing the effort, cost, time & money in future develop new machine.

Identify Machine Components Available in Market.
This project work will first introduce the background of the study. Presents the design constraints that influence on the use, efficiency & benefits their impacts on machine. After that machine parts design all different existing machine assembly units will done to make a probable machine model.

Selection of Components for Machine as per design specifications
Following topic discuss the construction & working of system components. Various resources and factors were considered for getting the information on the project: First, the requirement of the field is to identify. The specification of the material is thought according to the need.

3. Description of Components

3.1 Lube oil

Lubricant oil used in high-performance diesel locomotives. These oils are made from high-quality base stocks that have exceptional thermal and oxidative stability. Special additives contained in these oils offer a high degree of detergency, dispersancy, and the required level of alkalinity to prevent the negative effects of high Sulphur fuel combustion

products.

Performance Benefits of Servo RR oils
Extend the life of the rings and cylinder liners.
Give turbocharger bearings proper protection.

Maintain the cleanliness of engine components.
Have a high alkalinity, which helps to resist the corrosive impact of Sulphur in the fuel.

SN	Characteristic	Limits
1	Appearance	Clear
2	ASTM Colour,Max	8.0 Max.
3.	Kinematic Viscosity@ 100 deg C, cST	15.5-16.3
4	Viscosity Index	110 Min.
5	Pour Point deg C.	Minus(-)21 Max.
6	Flash Point (COC) degC.	200 Min
7	Total Base No.,mg KOH/gm	10.5-12.5
8	Sulphated Ash %wt.	1.30 - 1.42
9	Foaming Characteristics Tendency/stability,ml of foam, max Sequence I Sequence II Sequence III	10/Nil 50/Nil 10/Nil
10	CCS cP max	9500 @ -15deg C
11	Sulphated Ash %wt min-max	1.30 - 1.42
12	Zinc % wt min-max	0.030 to 0.034
13	Phosphorous % wt min-max	0.028 to 0.030
14	Calcium % wt min-max	0.0360 to 0.400
15	Silica ppm	10 max
16	Sodium ppm	30 max

Figure 3.1: Properties of Lube oil

3.2 DC Motor

An electrical motor that converts direct current (DC) electrical energy into mechanical energy is referred as a direct current (DC) motor.

The most prevalent forms are based on magnetic field forces.

A DC compound motor, also known as a compound wound DC motor, is a Self-Excited Motor that is made up of both series and shunt field coils coupled to the armature winding. The series field winding connects in series with the Armature, and a shunt field winding is connected in parallel to the armature.

In a nutshell, a DC compound motor is a hybrid of a Shunt-Wound DC motor and a Series-Wound DC motor. As a result, the compound motor offers a strong starting torque and efficient speed management.

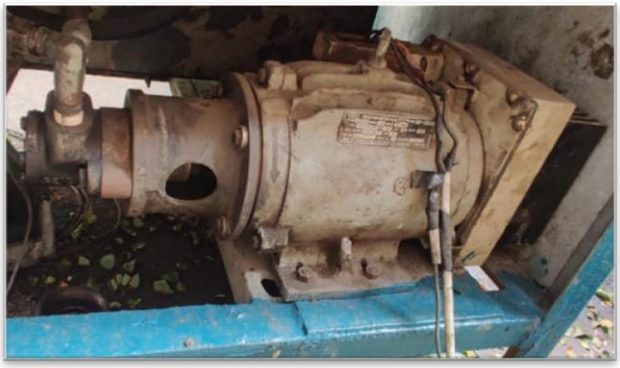

Figure3.2:DC motor with Pump

3.3 Gate Valve

Gate valves are used to stop the flow of fluid by placing a rectangular gate or wedge into the flow route.
Gate valves take up extremely less space along the pipe axis and barely hinder fluid flow when completely opened, allowing gate valves to provide straightway flow with very little pressure loss.
Gate valves are made up of three basic parts: the body, the bonnet, and the trim. Hinged, screwed, or welded connectors are commonly used to connect the body to the pipe. The bonnet, which houses the moving components, is often bolted to the body to allow for cleaning and maintenance. The valve trim is made up of the stem, gate, wedge, disc, and seat.
The primary operation mechanism is really simple. Turning the hand-wheel turns the stem, which is translated into vertical movement of a gate through threads. They are classified as multi-turn valves because they require more than one 360° rotation to fully open/close the valve. When the gate is raised from the flow route, the valve opens, and when it returns to its closed position, it closes the bore, resulting in the valve being fully closed.

Specification of Gate Valve

Highly corrosion-resistant (more so than bronze)
Highly durable
Handle pressure of range 0-25 bar
Malleable

Figure 3.3: Gate Valve

3.4 Pressure Gauge

A pressure gauge is a device that measures the intensity of a fluid. Pressure gauges are necessary for the setup and

adjustment of fluid power equipment, as well as for troubleshooting. Fluid power sources would be unpredictable and ineffective without pressure gauges. Gauges help to verify that there are no leaks or pressure variations that might damage the hydraulic system's operation.

Because the hydraulic system is intended to operate within a specific pressure range, the gauge must be rated for that range as well.

Figure 3.4: Pressure Gauge

3.5 Relief Valve

A relief valve, also known as a pressure relief valve (PRV), is a type of safety valve that is used to manage or restrict the pressure in a system; otherwise, pressure might build up and cause a process upset, instrument or equipment failure, or fire.
A Relief Valve is activated by intake static pressure and has a progressive lift that is proportionate to the rise in pressure above the opening pressure. It is generally utilized for liquid service and may be equipped with an enclosed spring housing appropriate for closed discharge system use.

A crucial component of a lubricating oil system is the relief valve. This valve is installed on the delivery side of the lubricating oil pump to guarantee that the oil pressure does not exceed the preset limit.

When the pressure from the lubrication oil pump exceeds the spring tension on the valve, the valve is raised off its seat to alleviate the excess pressure. By sending a part of the oil to the engine sump, this saves the system from harm caused by increased pressure on cold through.

Parts of relief valve:
Guide
Spring
Bolt
Housing

Figure 3.5: Relief Valve

3.6 Regulating Valve

A pressure regulator is a valve that regulates the pressure of a fluid or gas to a predetermined level. Regulators are used for gases and liquids, and they can be integrated with a pressure setting device. A regulating valve keeps the lubricating oil pressure constant. The valve in question is an adjustable type regulating valve. To adjust the pressure, remove the valve cover and spin the adjustment screw clockwise to raise the pressure and anticlockwise to reduce it.

Parts of Regulating Valve
Spring
Piston
Adjusting screw, retaining nut and lock nut
Outer body
Valve cap

Figure 3.6: Regulating Valve

3.7 Filter

An oil filter is used in railway locomotives to remove impurities from the lubricating oil. The inclusion of a filter prevents significant harm to the test apparatus. The filter captures unwanted particles such as stones, metallic particles, or dust that would otherwise pass through the header/pipes. It is advised that filters be used to extend the life of the test apparatus. In hydraulic systems, suction filters are used to remove pollutants from process fluids, preventing harm to sensitive system components. Their porous filtering medium collects particles and contaminants

when fluid runs past them.

Figure 3.7: Filter

3.8 Hydraulic Hose Pipes

The fluid is directly controlled by the regulating valves and delivered via hose pipe. This pipe can withstand pressures of up to 12.5 MPa. A hydraulic hose is a tube used to transport hydraulic fluid to or from hydraulic components such as valves, actuators, and tools. Because hydraulic systems commonly run at high or extremely high pressures, it is normally flexible, strengthened, and made with numerous layers of reinforcement. Hydraulic hose is found in a wide range of industrial hydraulic systems. When looking for hydraulic hose, dimensions, performance standards, construction alternatives, and features are all crucial factors to consider.

Figure 3.8: Hydraulic hose pipe

Specifications of hose pipe
Construction:
Tube: Black, Oil resistant synthetic rubber.
Reinforcement: Single wire braid.
Cover: Closed two textile braids impregnated with an oil and mildew resistant synthetic rubber compound.
Application:
Hydraulic, crude, fuel and lubricating oils, gasoline.
Temperature:
-40°C to +93°C (-40°F to +200°F). (Intermittent +120°C).

3.9 Lube Oil Tank

This tank is used to store lubricant oil. This tank has a capacity of 25 litres. There should be a minimum of 21 litres in order for the filter to be thoroughly submerged.

Figure 2.9: Lube Oil Tank

Parts with specification

Table 3.1: Specification of components

Components	Specification
Lube oil	Servo RR 606 MG SAE grade 20W- 40 Kinematic Viscosity cST @100 degree C - 15.5 – 16.3 Viscosity Index, Min. – 110 Flash point (COC), °C Min. – 200 Pour Point, °C Max. - (-) 21 Total Base No., mg. KOH/g (Typical) - 17
Lube oil tank	Material- Galvanized Iron Capacity- 25 litre
Regulating valve	Pressure- 7.5 kg/cm^2
Relief valve	Pressure- 8 kg/cm^2
Hydraulic hose pipe	Handling pressure- 12.5 Mpa Material- synthetic rubber Inner Diameter- ½"
Galvanized pipe	Diameter- 1 inch
Motor	RPM- 1200 ARM/VOLT- 74 ARM/AMP- 9 KW/HP- 0.55/0.75
Pressure Gauge	Company name- MIDLAND Material- Black steel case ring, Plastic lens. Pressure range- 0-11 kg/cm^2
Filter	Material- Aluminium Diameter- ½"
Gate Valve	Material- Brass Diameter- 1 inch

4. Design and Fabrication

Table 4.1: Process sheet

S. No.	Process used	Parts on which process is applied
1	Arc Welding	Pipe, Table, Base Plate
2	Grinding	Pipe, Table, Base Plate
3	Drilling	Base of tank, Safety Plate, Plate of pressure gauge, Aluminium sheet
4	Polishing	Top surface of Table
5	Lapping	Safety plate

4.1 CAD Model of Test rig

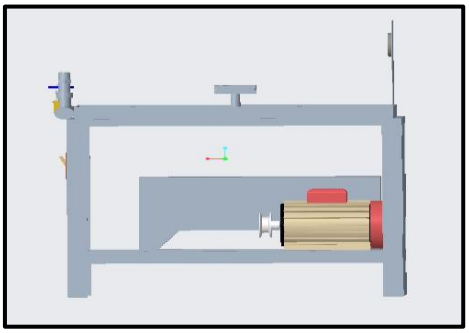

Figure 4.1: Side view

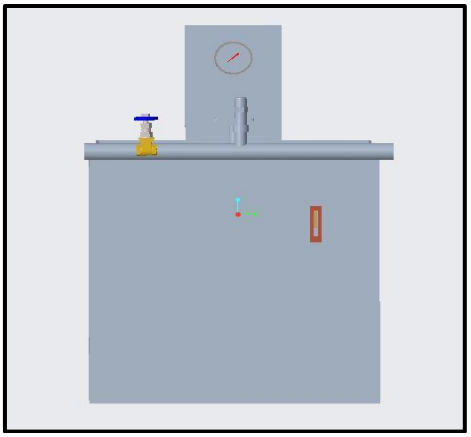

Figure 4.2: Front view

Figure 4.3: Fabricated test rig

5. Workingof Test rig

5.1 Flow diagram of test rig

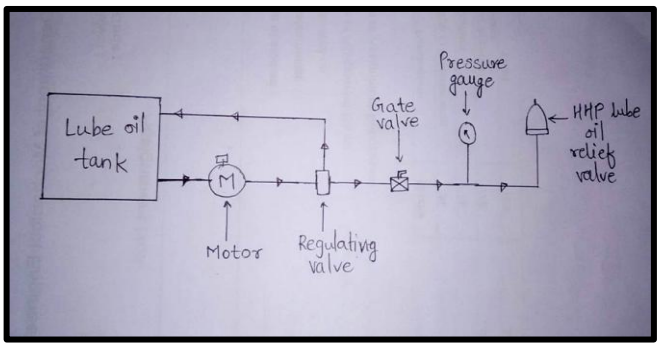

Figure 5.1: Flow diagram of test rig

5.2 Working of test rig

The motor will pump the lube oil from the lube oil tank to the regulating valve, which will use a pressure gauge to detect its pressure.

When the oil reaches the regulating valve, if the pressure meets the requirements, it is sent to the gate valve.

If the pressure obtained does not equal the prescribed pressure, it will be routed to the lubricating oil tank and the process will be repeated.

When the oil reaches the gate valve, it is routed to the base plate, where our relief valve will be installed.

As the oil is allowed to flow through the relief valve to check the pressure, it is determined whether or not that relief valve may be utilized again.

If the pressure displayed by the pressure gauge is less than or more than the required range, the relief valve requires some adjustments/repairs.

6. Experimental Setup

6.1 Apparatus

Relief valve for testing
Nut size 18
Bolt and Box spanner size 18

6.2 To set regulating valve proceed as follows:

Turn on the gate valve.
Start the pump.
Close the gate valve until the proper pressure is displayed on the oil gauge.
Turn the valve adjusting screw until the valve begins to leak at the pressure displayed on the oil gauge.
On non-adjustable versions, resolder the adjustment screw.
On adjustable versions, tighten the lock nut.
Replace the adjustment screw cap and gasket.

6.3 Experiment procedure

When placing the relief valve on the test bench or in the engine, make sure the bypass port is pointing downward.
Start the engine.
Rotate the hand wheel to completely open the gate valve.
Check the pressure on the pressure gauge.
Repeat the procedure for each relief valve.

6.4 How to Assemble and Disassemble Regulating Valve

6.4.1 Disassembly

Remove the pipe work from the lubrication oil system.
Take off the valve cap and gasket.
On non-adjustable valves, remove the adjustment screw and retaining nut simultaneously. If the valve is adjustable, unscrew the lock nut and remove the adjustment screw.
Take out the retaining nut.

Take off the spring and piston.

6.4.2 Reassembly

Lightly oil piston and apply to valve body making sure it can be moved freely.

Apply spring, retaining nut, adjusting screw and on adjustable models, the lock nut. When adjusting, set valves to open at specified psi.

7. Observations

Specimen no.	Required pressure range (kg/cm^2)	Observed pressure (kg/cm^2)	Remarks
1344	6.5 – 8.5	8	Good
1156	6.5 – 8.5	7	Good
1156-2	6.5 – 8.5	6	Bad

8. Maintenance and Suggestions

8.1 Maintenance of test rig

Check to see that the connections are correctly seated in the switchboard.

Check that the lubricating oil tank is full, or at least that the level that immerses the filter is full.

Checking the filter on a monthly or quarterly basis, depending on how the test bench is used.

Cleaning the filter as undesired particles such as stones, metallic substances, dust, and so on gather.

For excessive usage, clean the regulating valve once a month, or quarterly for medium and moderate consumption.

If necessary, replace the gasket on the base plate.

If the relief valve does not meet our requirements, try adjusting the spring.

The spring length shall not be less than 114.30 mm under 141 kg load.

There might be a leak in the pressure gauge connection.

If the relief valve does not fit the safety plate or if the plate has certain markings, the lapping method should be used.

If there is dust or abrasive particles gathered on the safety plate, clean it with rough polish paper.

8.2 Maintenance of relief valve

The oil pressure release valve should be removed, and the parts should be examined in accordance with the Scheduled Maintenance Program.

Disassemble the valve and carefully wash all of its parts. Back off the valve guide all the way before removing the valve holder and spring, as specified on the valve's safety plate.

In order to assess their suitability for reuse, inspect the parts as follows:

Valve Spring-

Examine the valve spring for any nicks that might lead to spring failure. Apply a 141 kg load to the valve spring to test it. The spring length should not be less than 114.30 mm under this load.

Valve Guide-

Check the inside diameter of the valve guide using a telescopic gauge. Clean up the bore if the interior diameter is rough or mildly scuffed, but do not exceed the maximum diameter.

Valve-

Look for roughness and minor scuffing on the valve stem. To eliminate high areas, the stem can be manually stoned and rubbed. If the stem is heavily galled, replace the vale.
Check that the valve stem's outer diameter is not less than the minimal limit.

Also, examine the squareness of the valve face to the stem, measuring from the outer edge of the valve face, for a possible bent valve or deformed face. It is necessary to specify the total indicator reading.

8.3 Suggestions

Because of environmental circumstances, the hydraulic hose pipe might become inflexible.
If required, replace the regulating valve.
If the gate valve fails to function correctly, it can be replaced.
Regularly inspect the gasket.
Check the pressure gauge's operation on a regular basis.

9. Result

As we can see, one of the relief valves is not in good enough condition to reuse; consequently, we must either change the relief valve's spring or scratch it because it is not fit to be reused.

10. Conclusions

The testing of valves before to their usage on locomotives reduces mistakes or disasters. It will save time and improve job efficiency. The needless expenditure of money on obtaining a new relief valve every time would be reduced since we would know which relief valve can be utilized to lessen the danger and harm to humans.

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