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Automated Trolley Mounted Test Rig for Testing Of Ball Valves

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Abstract: *Transportation of a Fluid is done by channels in the former age as well as in recent times. These channels need to direct the flow of Fluid according to various requirements. Thus an arrangement is provided in the channels for the control of Fluid flowing through it. There are different types of Valves according to the situation. In this project we will be focusing on testing of Ball Valves which are basically Flow control Valves. There are two types of Ball Valves viz. Floating Ball Valves and Trunnion Ball Valves.*

After the manufacturing of Ball Valves it is essential to test them for detecting any flaws or leakages. For this purpose we use a device called as Test Rig. A Test Rig is a form of Universal Testing Machine. Depending upon different material standards, testing standards, Fire safe standards, Design standards various types of Test Rigs are used. In order to reduce Human efforts and to improve the efficiency of the process, we are implementing Automated Trolley mounted Test Rig. The bulkiness of the former Test Rig has been reduced and made compact. Hence making it use a lesser carpet area. For convenience purpose we are also making it Mobile.

Keywords*: Floating Ball Valves, Trunnion Ball Valves, Fire safe standards, Test Rig, Universal Testing Machine.*

1. Introduction.

The Test Rig is a device which is used for testing and detecting the flaws and leakages if any. It consists of a form of Universal testing Machine, a dashboard which consists of pressure gauge, hydraulic and pneumatic controls, Actuators. It also consists of a tank for storage of hydraulic fluid.[1] Depending upon the material standards, testing standards, Fire safe standards, Design standards, floating or Trunnion Ball Valves are mounted on Test Rig and accordingly Torque is applied.

2. Problem Statement.

The current Test Rig requires more Human efforts for testing of each Ball valve, although a Gantry Girder is used. When worker loads the Ball valve, the upper plate impedes the process. Because of Manual Testing, there are lots Human Errors. As the Test Rig is Bulky, it is not feasible to locomote the entire setup throughout the industry premises.

Objectives -
Our aim in this project is to design a test rig that would supplant the existing test rig or can be an alternative for testing of ball valve.

1. Easy detection of leakages with the inclusion of appropriate sensors and alarms.
2. Reduce human efforts.
3. Make the test rig mobile.
4. Improve process efficiency.
5. Eliminate human errors through automation.
6. Improve testing time.
7. Ameliorate safety measures.

3. Literature Study.

3.1 Why is modified test rig needed in Industry?

The modifications made in the existing test rigs will prove essential where the whole world is moving towards automation. It can be used in petrol industries and many more chemical industries.[2] Our aim is to fully automate and use it in mass production. For large scale production, this automation idea will prove real useful and it will save time and money which are most important factors considered in the industry.

3.2 Modifications and their advantages.

The existing test rig for ball valves consists of a table on which two columns are bolted, a base plate resides on this table between the two columns and aligned through two guide ways. The columns hold an upper plate on the top with the help of bolts. The base plate is lifted with the help of a hydraulic actuator placed at the bottom.

Figure No.1 Existing test rig for ball valves.

Table No.1 Modifications and their advantages.

Modifications	Advantages
Sliding Base plate with T slots	T slots are provided to facilitate sliding action of base plate for loading and unloading
Four bolted columns	Avoids hindrance caused by two columns and easily replaceable due to bolting.
Sensors and alarms	Leak detection and indication to worker.
Compactness of unit	No auxiliary components and clubbing of dashboard, tank, UTM, actuator, pressure gauges, etc in one single unit.
Perforated safety panels	Increased safety during testing of high pressure Trunnion ball valves.
Base plate jaws	Jaws provided for proper alignment and clamping purpose

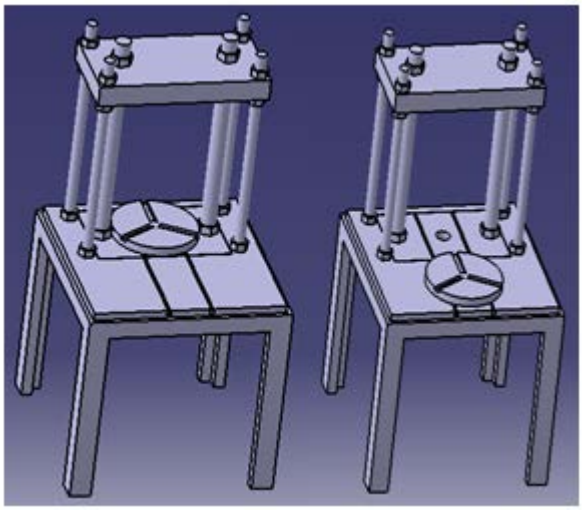

Figure No.2 CAD Model demonstrating sliding of the base plate

3.3 Formulae used for calculation of buckling of columns, threading on columns and actuator design.

E=Modulus of elasticity (MPa)
I= Mass moment of inertia of column (mm^4)
L=Length of column (mm)
Le=Effective length of column (mm)
Where Le=L/2
Δ=Deflection of column
P=Load acting on column (N)
A=Cross sectional area of column (mm^2)
α = Pitch angle (degree)
Dm=Mean diameter (mm)
Do=Outer diameter of threads (mm)
Di=Inner diameter of threads (mm)
Φ = Friction angle
μ = Coefficient of friction
W=Weight to be lifted by threads (N)
Mt=Torque required for lifting (Nm)

- $P= 4\Pi^2EI/L^2$
- $\Delta L= PL/AE$
- $\text{Tan}\,\alpha = L/\Pi\, Dm$
- $\text{Tan}\,\Phi = \mu$
- $P=W \tan(\Phi+\alpha)$
- $(Mt)c=\mu*W*(Do+Di)/4 + P*Dm/2$

4. Generalized working of the Modified Test Rig.

1. Hold the Ball Valve using a Gantry girder.
2. Slide the Base Plate out at a position directly below the Gantry.
3. Mount the Ball Valve and Clamp it at appropriate position by using jaws provided on the base plate.
4. Slide the base plate inside the Frame by using horizontal hydraulic actuator and lock the base plate on the guide plate by using locking screws.
5. Mount Flanges above and below the Ball Valve for avoiding any damage to the Ball Valve.
6. Do the necessary connections and the complete the testing procedure to detect the leakages if any by using sensors and alarms.
7. And unload the Ball Valve using the same procedure as that of the loading.
8. In case of Testing of High Pressure Ball Valve (Trunnion Ball Valve) enclose the assembly using perforated safety panels.

5. Design Parameters.

To increase the process efficiency the following parameters should be examined carefully.

1. Buckling:
Appropriate diameters should be selected for columns and Actuator piston rod to prevent them from buckling or any other deflection.
2. Jaws:
Jaws should be selected such that they will exert sufficient clamping force on the Ball Valve so that it can be properly positioned.
3. T slots:
The ratio between width of smaller and larger sections of T slot should be 1:2. Also there should be a clearance of 1 mm to avoid friction and to ensure proper sliding motion. If needed lubricants like grease can be used.
4. Safety Panels:
The Safety Panels should be designed in such way that they will provide complete protection in case if any of the components explodes while testing of high pressure ball valve (Trunnion Ball Valve).
5. Threads:
Sufficient Threading should be provided on columns, guide ways, column nuts and guide way nuts so that upper plate can be raised or lowered and it should also withstand the Lifting and Lowering Torque.
6. Sensors and Alarms:
Sensors and Alarms should be positioned precisely and they should be rigid in construction to withstand the high pressure operations.
7. Guide Plate:
The Base Plate should be properly aligned with the Guide plate and the Locking screw should be properly positioned to avoid any misalignment.
8. Trolley: Installation of wheels will help to locomote the whole unit anywhere in the industry premises.

6. Conclusion.

By implementing above changes less Human effort will be required for Loading, Testing and Unloading of Ball Valves. It will also simplify the testing procedure as the hindrance caused by the upper plate is successfully rectified. Testing procedure will be simplified by using Sensors and Alarms.

7. References.

[1] Davis, Joseph R. (2004), Tensile testing (2nd ed.), ASM International, *p. 2*, ISBN 978-0-87170-806-9.

[2] Jump up^ NIST, Large Scale Structure Testing Facility, retrieved 04-05-2010