International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 5 May 2021, pp: 768-775 www.ijaem.net ISSN: 2395-5252

Design and Development of Hydro Test Set up for Sluice valve Testing

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Submitted: 05-05-2021 Revised: 17-05-2021 Accepted: 20-05-2021

ABSTRACT -Hydrostatic testing is universally known and accepted as a means of demonstrating the fitness of a pressurized component for service. After a test, a pipeline or pressure vessel can be expected to safely contain its intended operating pressure. The confidence level that a pipeline or pressure vessel is fit for safe service increases as the ratio of test pressure to operating pressure increases. This highly beneficial aspect of hydrostatic testing applies not only to a new component to be placed in service for the first time. A similar benefit accrues to an in-service component if that component is taken out of service after a period of time and subjected to a hydrostatic test. A "revalidation" test of the latter type assures either that no significant time dependent deterioration of the component has taken place or that any segment that has been significantly degraded will be revealed and eliminated. There are limitations to the use of hydrostatic testing to revalidate integrity. Some are economic, some are technical, and some are both economic and technical in nature. First, taking a segment of a pipeline out of service means loss of service for the period of the test

I. INTRODUCTION

Some operators may have this option; others may not. Certainly an operator cannot afford to cut off customers without providing alternative supplies. For single-line systems, this may not be possible. Technical limitations include the fact that a test is a go/no-go device. A test reveals weaknesses by causing ruptures or leaks; it does not indicate, for example, other areas where active corrosion may be taking place. A limitation that has both technical and economic implications is that a level of test pressure to operating pressure sufficient to generate high confidence may result in numerous test breaks or leaks. Repeated test failures may actually reduce confidence in the final margin of safety demonstrated by the test, and such failures will certainly add significantly to the cost of the test and the time out of service. With careful weighing of the benefits and limitations nevertheless, some pipeline operators will be able to use hydrostatic testing as a means of integrity assessment. The objective of this presentation is to show how such testing might be used to assess the integrity of existing gas pipelines

1.1 Benefits and limitations of hydro testing

Hydrostatic Testing is a process where components, such as piping or pressurevessels are tested for strength and leaks by being filled with pressurized liquid. For pipelines, the pipeline is removed from service before testing. All oil and/or natural gas is then vented off and the line is mechanically cleaned.

Advantages:-

1. Hydro testing satisfy the quality of valve / centrifugal pump/ pipeline.
2. Hydro testing minimizes the risk of damage.
3. Hydro testing ensures the leak free plant pipeline.

II. SLUICE VALVE

Sluice Valves are primarily designed to start or stop flow, and when a straight-line flow of fluid and minimum flow restriction is needed. In service, these Valves generally are either fully open or fully closed.

Advantages of using Sluice Valves:
1. Good shutoff features
2. Sluice Valves are bidirectional and therefore they can be used in two directions
3. Pressure loss through the valve is minimum

2.1The major drawbacks to the use of a Sluice Valve are:
1. They cannot be quickly opened or closed.
2. Sluice Valves are not suitable for regulate or throttle flow.
3.They are sensitive to vibration in the open state.

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2.2Concept:

In today's technology, all are trying to save the cost. In current industrial world motorized operated valve testing set ups are available, but they are costlier and require more time for manufacturing and assembly.

So to save the cost and simplification purpose we have taken this opportunity to develop manually handling Design and development of Sluice valve testing set up**.**

Application:-

1.For pressure testing pipelines, vessels, fittings, heat exchangers, sprinkler systems, hoses, and valves.

2.For manually operating hydraulic equipment.

III. LITERATURE REVIEW

3.1 A Procedure for the hydrostatic pressure testing of marine facility piping

Bud Pingree P.E. et al. The purpose of this methodology is to provide auseful alternative that a marine facility operator can implement to facilitate hydro test planning, performance and interpretation. Providing precise and complete test data will allow the facility operator and California State Lands Commission (CSLC) to more effectively assess the validity of hydrostatic pressure tests.

This methodology is intended for use in conjunction with the recently developed CSLC testing calculation (spreadsheet) applicable to testing of marine facility piping and pipelines under the jurisdiction of the California State Lands Commission as defined in Article 5.5 of the California Code of Regulations. This is not regulation; however using these tools may help to improve the consistency and quality of data collected during the test.

3.2Operation & maintenance manual API 6a slab gate valve

John F. Kiefner et al. The purpose of this paper is to clarify the issuesregarding the use of hydrostatic testing to verify pipeline integrity. There are those who say it damages a pipeline especially if carried out to levels of 100 percent of more of the specified minimum yield strength (SMYS) of the pipe material. These people assert that if it is done at all, it should be limited to levels of around 90 percent of SMYS. There are those who insist that pipelines should be retested periodically to reassure their serviceability. The reality is that if and when it is appropriate to test a pipeline, the test should be carried out at the highest possible level that can be feasibly done without creating numerous test failures. The challenge is to determine if and when it should be done, the appropriate test level, and the test-section logistics that will maximize the effectiveness of the test.

3.3 Design and Analysis Of Lead Screw

Aman B. kotwal et al. The main objective of analysis of lead screw is todetermine various types of stress and deflection at different mode shapes. The output needs from this work to investigate strength of lead screw for various loading condition. The deep knowledge of stresses and deflection is involved in this analysis. This work study vital for large scale plants. In industry fixture facing problems like unwanted energy waste and low production rate. This creates economical and technical problems that can solve by this work. FEA software is used for stress and deflection analysis and shows effect of different loads for calculating different parameter and mode shape.

For design purpose mechanical analysis of lead screw affected by various parameters like efficiency, torque requirement and load capacity. There are numerous important for successful design of lead screw for drive system. Whenever sliding motion exists in machine, system create vibration and which severally affects the function of system. In this work the lead screw is slide with the ball screw as system operate. The most common problem for the lead screw is backlash. The backlash severely affect the position accuracy of lead screw, hence both design and manufacturing of lead screw may reduce the presence of backlash.

3.4 Optimizing Production Scheduling of Steel Plate Hot Rolling for Economic Load Dispatch under Time-of-Use Electricity Pricing

Hua-li Yang et al. Time-of-Use (TOU) electricity pricing, a practicaldemand response program implemented by many power suppliers to improve the peak load regulation ability of power grid, provides an opportunity for electricity users to implement Economic Load Dispatch (ELD), that is, cut electricity costs by reducing power loads during on-peak periods and shifting loads from on-peak to off-peak periods. Unlike conventional energy conservation to reduce absolute energy consumption, optimizing electricity costs under TOU pricing means that industrial users adjust their production schedule to avoid on-peak time periods, which will have significant effect on cutting electricity costs. In recent years, ELD under TOU pricing has become a hot area. Shrouf et al. Proposed a single machine scheduling problem, in which each time period has an associated price and the objective is to minimize electricity costs while

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considering traditional scheduling performance measures.

3.5 A Review on Thread Tapping Operation and Parametric Study

Hardik J. Patel et al. There is a tremendous technological development in themanufacturing industry and manufacturing industries are making large amount of effort for their mass production with best quality products having higher reliability and economical in cost. Now days the hand operated machines are replaced with the application of automation in automatic or semi-automatic machines which utilized to improve the productivity. Tapping may either be achieved by hand tapping by using a set of taps first tap, second tap & final (finish) tap or using a machine to do the tapping, such as a lathe, radial drilling machine, bench type drill machine, pillar type drill machine, vertical milling machines, HMCs, VMCs. Machine tapping is a process to produce the female threads inside the drilled hole. Machine tapping is faster and generally more accurate because human error is eliminated. Final tapping is achieved with single tap. Although in general machine tapping is more accurate, tapping operations have traditionally been very tricky to execute due to frequent tap breakage and inconsistent quality of tapping. Machine tapping can be performed by electric drives and the problems concerned with the machine tapping can be eliminated with the application of pneumatic tapping machine.

3.6 "Weight Optimization Of 12"-600 Gate Valve By Using Finite Element Analysis And Experimental Stress Analysis"

Mr.Shridhar S. Gurav et al. In today's world of technological advancementin the field of fluid transfer systems, various components are incorporated in the field of fluid transfer systems for efficient transfer of fluid.one of the most important component that regulate flow of fluid through transfer lines are VALVE. A valve is device that regulates, directs or controls the flow of fluid by opening, closing or partially obstructing various passage ways they are used in various applications like industrial (oil, gas, power generation, mining chemical manufacturing),military, commercial, residential. Valves are various types having wide range of size and applications.so considering importance of valve we are reduce the manufacturing cost of valve.so major weight of body in assembly of valve that can be reduced without disturbing other parameters like pressure.

3.7 Proposing a Model for Evaluating Gate Valve Cover Manufacturing Methods by Value Engineering and Data Envelopment Analysis Approaches

M. Ziaei et al. Energy resources are considered as the major nationalcapitals of each country. Meanwhile, fossil fuels are of the rarest energy resources for which correct and optimal use plays a crucial role in dynamics and improvement of countries. This issue doubles attention to the equipment related to energy resources. Focusing on gate oil valve as one of the oil and gas control equipment, this article studies different manufacturing methods of its cover.

3.8 Structural Analysis of Gate Valve Body Using F.E.A.

Mr.PradipBhaskarPatil et al.Gate valves are machine elements whichare commonly used to control the flow of volatile, often toxic, liquids and gases and keep them from being emitted into the atmosphere or spilled on the ground or into the water. This gate valve is widely used in various industries like refineries, petrochemical complexes, fertilizer plants, power generation plants (hydro - electric, thermal and nuclear) steel plants and allied industries etc. for a various process. This paper gives basic methodology of gate valve body design by using cad technologies and FEA at maximum operating pressure. The main purpose is structural analysis to be carried out for determining stresses and strains developed in the valve body. The first design of a product that has been in the head of the engineers is illustrated in computers and then produced by computer-aided machines. The analysis processes of a product of which solid modeling have been accomplished can be carried out by ANSYS and similar analysis programs in digital environment, before starting manufacturing. These processes give the companies flexibility in the development of a new product by providing design capability with minimum cost and minimum waste of time.

IV. PROBLEM STATEMENT

There is flange sealed hydro-test procedure is used for testing the valve and centrifugal pumps. In this present procedure the following components are required for each and every different model according to flange dimensions.

1.The flanges
2.Nut and bolts
3.Gasket as per flange size.

In this current testing, we have to use flanges as and nut bolts according to valve size. If the valve size changes then different flanges, nut

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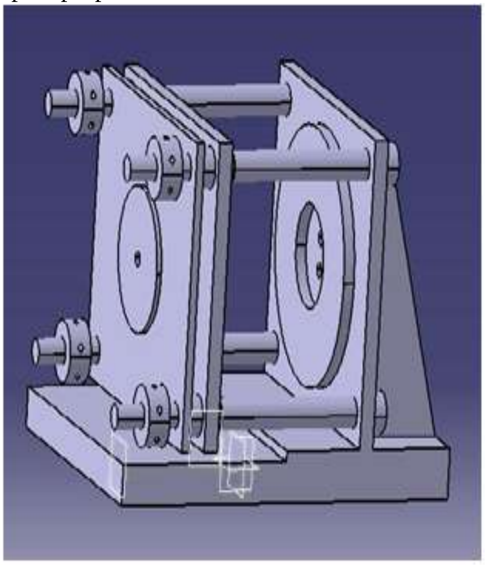
and bolts are required. Hence following problems are involved in the present test set up.
1.For each and every different size valve different flanges, bolts, Gaskets and nut bolts are required.
2.Manual material handling more and hence in this present method time required is more.
3.During the tightening of bolts uneven effort and torque is applied on the flanges and so leakage may present from the flange during the Hydro test.

Fig 1.1:- Present condition of hydro test

So in this project we have worked on the present problem involved and we have developed the Hydro test set up in this we have eliminated the flanges and nut bolts are required for the hydro test. In this we have used motorized mechanism so that manual effort can be reduced.

4.1Objective:
4.1.1 Project objectives:-
a) To develop standard simple set up which is user friendly.
b) To eliminate required inventory (Flanges and nut-bolts) and accessories required for existing set up.
c) To develop set up Economical and time required for testing should be minimum.
d) To reduce human stress and strain.
e) To reduce manual errors during the testing.

V. PROPOSED PROJECT WORK:-
1. Designand development of gate valve testing set up **as per API 598.**
Design Specification:
1.Valve size (inner diameter = 150mm- 350 mm)
2.Pressure testing capacity for seat test : 16 kg/ cm2
3.Pressure testing capacity for Body test : 20 kg/ cm2
4.Valve type: Sluice valve
2. Manufacturing of test set up.
3. Validation and Testing, observation of test set up as per API and IS standard.
4. Analysis of pressure plates and screw arrangement.
5. Report preparation and conclusion.



VI. NUMERICAL DESIGN & ANALYSIS:-
6.1 Design considerations:-
While designing our attachment, the following considerations were taken into account
1. The device should be suitable for local manufacturing capabilities.
2. The attachment should employ low-cost materials and manufacturing methods.
3. It should be accessible and affordable by low-income groups, and should fulfill their basic need for mechanical power
4. It should be simple to manufacture, operate, maintain and repair.
5. It should employ locally available materials and skills. Standard steel pieces such as steel plates, iron rods, angle iron, and flat stock that are locally available should be used. Standard tools used in machine shop such as hack saw, files, punches, taps & dies; medium duty welder; drill press; small lathe and milling machine should be adequate to fabricate the parts needed for the machine.
6. Excessive weight should be avoided, as durability is a prime consideration

6.1.1 Design of plate
Calculation of force:

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Pressure = 30 bar
Valve flange Diameter = 200 mm
$A = (\pi/4)(200)^2$
$A = 31415.9\ mm^2$
F = P * A
F = 130 KN (max)
Plate Dimensions:
By considering valve diameter taking length of flange = 300 mm So, Area of the flange
A = 700* 700
$A = (490000)\ mm^2$

6.1.2 Design of power screw:

Type of screw: Acme threaded power screw
Material = Mild Steel
Properties: Compressive Stress = 448 N/mm^2Shear Stress = 224 MPaFOS = 5
d_c = 43.5 mm
From standard power screw chart,
d_o = 50 mm, P = 7 mm, A_c = 1452.2 sq. mm.
Mean diameter
d_m = d- 0.5P
= 46.5 mm
h = depth of the thread =4 mm
W = width of tooth
W=0.53*7=3.71 mm

Lead = Pitch = 7 mm
Selection of cylinder:
Assume diameter of piston = 40 mm
Area A = (40)2
A = 1256.63 mm2

F =P*A
F=448 * 1256.63
F=562973.40 N
F=562KN

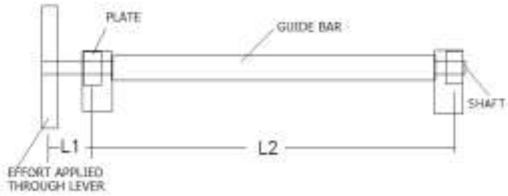
Therefore selected diameter of piston is safe.

6.1.3 Design of Guide shaft

To design of shaft we have considered three loading conditions:-

- Against torsional moment
- Against bending moment
- Against both combining torsional and bending moment.

b) Design of shaft against torsional moment
Total load W= 375N. (The value is taken from the torque bar and considered as per discussion had with sponsors technical team)
The Guide shaft lever arm diameter considered = Dp = 100mm



So Maximum Torque T = Effort x Radius of pulley
Total torque on screw shaft = 375 x 50 = 18750 N-mm

Total toque on screw shaft T = 18750 N-mm.
Ordinary transmission shafts are made of medium with carbon content ranging from 0.15 to 0.40% such as 30C8 or 40C8. These steels are commonly called as machinery steels. For shaft design, 40C8 is used [**Machine design Data Book by V. B. Bhandari, McGraw Hill Education (India) Private Limited, pp. 2.13**].
$S_{ut} = 630N/mm^2$, $S_{yt} = 350N/mm^2$,

As per ASME code

The permissible shear stress without keyways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material whichever is minimum. Therefore,
As the keyways are present, the above values are to be reduced by 25%.
Max torsion moment equation is given by
Where T = 18750N-mm
By using above equation drive shaft diameter d = 10.66mm ……………….A
As per manufacturers data and roller length the L1 and L2 is considered
L1 = 100 mm
L2 = 600mm

Maximum bending moment acting on the input shaft

Load of plate and jerk considering, the total static load considered
= P = 100kg = 1000N
Maximum bending moment,
Ma = 1000x600/2 = 300000N-mm
As per considering the application the spray procedure is non contacting type so considering factor of safety = 3
σ = 210 N/ mm2 considering factor of safety = 3
By using above equation drive shaft diameter d = 24.95 mm ………………..B
From equation A and B we have selected the diameter of shaft = 30mm at middle. Hence nominal diameter of guide shaft is selected 40mm

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According to maximum shear stress theory

Equivalent Torque:-

$T_e = \sqrt{(Kb\ Ma)^2 + (Kt.T)^2}$

From design Data book K_b&K_t =1

$M_e = \frac{1}{2}[M + \sqrt{(Kb\ Ma)^2 + (Kt.T)^2}]$

We get,

Te = 300585N-mm

Me = 300292 N-mm

Also We have

$T_e = \frac{\pi}{16} d^3 \tau$ & $M_e = \frac{\pi}{32} d^3 \sigma$

τ= 56.72N/mm^2<78 N/mm^2 and

σ= 113 N/mm^2< 210 N/mm^2

By using above equation we have checked the allowable shear stress and allowable bending stress and it is seen that the both values are within limit hence design is safe.

VII. TESTING OF HYDRO TEST SET UP -

Sr. No	Points observed	Existing manual method	New developed method mechanism
1.	Labour requirement Per day	02 = UnSkilled labor	01 unSkilledlabour
2.	Time required	Totally depends on manual experience	Standard time as per Valve standard API598
3.	Space required	For template and accessories rack and cupboards are required	Storage space required for machine
4.	Electricity required for mechanism or accessories	NA	NA
5.	Material handling	More than developed mechanism	Material handling is very less.
6.	Manual effort	More required	Very less required
7.	Maintenance	15Rs per person hospitality charges	Maintenance cost considered 10% annual of total cost of machine

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VIII. PAYBACK PERIOD ANALYSIS:-

Sr No	Points considered / activity / cost	Cost for manual Method	Cost for developed Mechanism
01	Labour Cost	`Labour requirement = 02 numbers Cost for Unskilled labor = Rs.300 per day Unskilled labour = 02 number **Total cost** = 300 x 2 = Rs.600	`Labour requirement = 01 numbers Cost for Unskilled labor = Rs.300 per day **Total cost** = 300 x 1 = Rs.300
02	Maintenance cost	For per labour hospitality Rs.15 per day Total cost of 2 labour = Rs.30/-	10 % of initial cost =Rs.6000 per year Working days considered 250 Per day maintenance charges = Rs.24 For labour hospitality Rs.15 per day
03	Storage cost	Neglected	Not required
05	Electricity charges	NA	NA
04	Labour charges of Production per day	630 per day	300+24+15 = Rs.339 per day
	Total saving per day	= 630 – 339= 291 Working days per year =250 days Per year saving= 291*250 = 72750/-	

So from above analysis it is concluded that
Payback Period = 60000/ 72750
= 0.824 year

So from above analysis it is seen that the payback period for developed mechanism is 1 year months

IX. CONCLUSIONS

1) Design of hydro test set up is safely placed on numerical analysis.
2) Body and shell test are performed as per standard API 598. And it is confirmed that hydro test set up meets the requirements of API 598 standard.
3)Total cost of with developed hydro test set up reduced per day cost by Rs.290. and Payback period is less than one year.
4) Therefore with developed hydro test set up testing time , labour cost and efforts , maintenance cost , testing cost & effort is reduced.
5) Flexibility and accuracy of setup is increased.

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