International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue12, December-2014

# Design and FSI (Fluid Structure Interaction) Analysis of Globe Valve: A Literature Review

Pratik. P. Nagare[1], Prof. Harshal. A. Chavan[2]
[1]PG Scholar, [2]Assistant Professor,
(Mechanical Engineering Department,
MET's Institute of Engineering, Bhujbal Knowledge City, Nashik, India)

***Abstract*- A Globe valve is frequently used as control entity in applications where the incoming velocity is fast and the pressure is relatively high. The main insistence of this review is to study the design and analysis of the valves. Finite element analysis (FEA) is a fairly recent discipline crossing the boundaries of mathematics, physics, and engineering and computer science. The method has wide application and enjoys extensive utilization in the structural, thermal and fluid analysis areas. Also Research in the fields of computational fluid dynamics and computational structural dynamics is still on-going but the maturity of these fields enables numerical simulation of fluid-structure interaction. Fluid-structure interaction (FSI) occurs when fluid flow causes deformation of the structure. This deformation, in turn, changes the boundary conditions of the fluid flow. A comprehensive literature review of the application of these methods in the area of design and analysis of valves has been introduced here.**

***Keywords- Simulation, Fluid-structure interaction, Finite element analysis, Thermal analysis*.**

## I. INTRODUCTION

A globe valve is a type of flow control device that controls the flow of gas, oil or water. Globe valve typically works with high velocity flow and low pressure loss at valve openings from $0^0$ to $90^0$.Valve analysis in the past was performed using experiment methods, which required a number of equipment, a lot of time, fund and so on. Especially globe valve, the only way is to reduce the prototype at an ideal scale, then do the analysis in a laboratory. However, it's not a good way to investigate the characteristic of globe valve. Nowadays, due to the fast progress of the computer visualization and numerical technique, it becomes possible to do it by using simulation technique. Another method wherein valve performance factors can be obtained is by using Computational Fluid Dynamics (CFD) software to simulate the physics of fluid flow in a piping system around a valve. However, only studying the fluid characteristics is not enough for globe valve because the pressure produced by the fluid is too high, which has great effect on the stress distribution in valve. FSI occurs when the flow of fluid influences the properties of a structure or vice versa. It is a great challenge to deal with such problems due to its complexity in defining the geometries, nature of interaction between a fluid and solid, multi-physics facts and requirements of computational resources. This kind of interaction occurs in a wide spectrum of engineering problems and as such remains a main attraction of engineering profession.

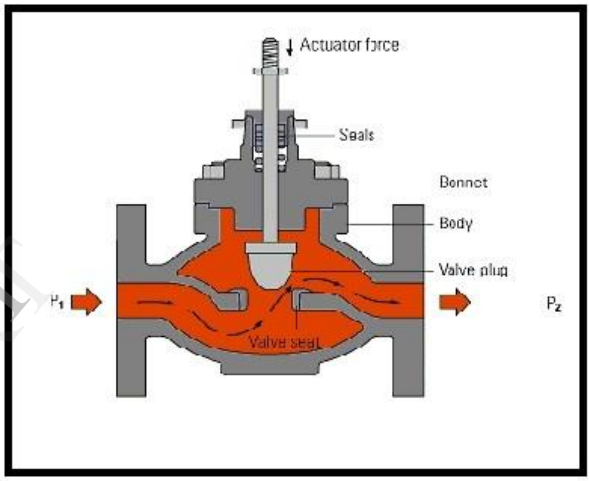


Fig.1.Globe Valve

## II. LITERATURE SURVEY

**G.Tamizharasi et.al. (2013)** presented the paper on CFD analysis of Butterfly valve [1]. The objective of this paper is to observe the flow pattern with various opening degrees around butterfly valve using CFX, also the flow characteristics and performance of butterfly valve were analysed using CFD as it provides better results. The future work represents by analysing the parameters as static and total pressure, intensity of turbulence, force.

**V. I. Sonawane et.al. (2012)** worked on CFD analysis of globe valve [2]. The objective of this paper is to observe the flow patterns of the valve using CFD software, by varying the flow rate and constant pressure drop access valve in a valve system. The future scope includes that these results of 3-D analysis can be used for design of low noise analysis and high efficiency valve for industrial applications.

**Rajeev Arya et.al. (2012)** presented the paper on flow analysis of Butterfly valve [3]. Butterfly valves are used to control the flow. It is important to design the valve (in such

a way) that would give high performance which results in optimum efficiency. The design of these valves are conventionally large, hence the performance of the valves cannot be predicted in laboratory. The main objective of this paper is to predict performance by using numerical technique which is less time consuming. The work stated here is the valve is modelled using ICEM 12, and the flow coefficient and head loss coefficient determined by CFX 12 for different opening of the disk for incompressible fluid.

**K Thanigavelmurugan et.al. (2012)** worked on the design and performance of the valve trim with the help of computational fluid dynamics [4].The main object was to find out the performance of the newly designed trim by the factors such as pressure drop, velocity variation and temperature distribution in the different stages of the valve. This was achieved using computational fluid dynamics.

**Yong H. Yoo et.al. (2006)** presented the paper to find out the steam flow rate of the control valve using computational fluid dynamics [5]. FLUENT was used to obtain the Charactertics valve curve and then the results were validated using OMEGA (optimized multidimensional experiment geometric apparatus) test. The flow Charactertics curve was obtained by translating ratio of actual mass flow rate versus the theoretical mass flow rate.

**Bxue Guan Song et.al. (2009)** investigated the safety of valve at the given inlet velocity of 3m/s [6]. This paper presents the numerical simulation using ANSYS and CFX software's. This was achieved by performing FSI analysis initially valve models were generated in three dimensions. The result of fluid analysis was imported to structure analysis as boundary condition. The results depicted the flow patterns, along with available flow for different patterns, showing that the valve need not be strengthened anywhere.

**Dr. Gurudutt Sahni et.al. (2014)** presented the different problems faced by the valve manufacturing industry [7]. This paper mainly describes the effects of strain, stress with respect to changing temperature. It describes the effect of higher temperature on the globe valve along with the modern FEA procedure.

**A. T. Bhosale et.al. (2013)** investigated the stresses developed in the butterfly valve disk [9]. This paper discusses the finite element analysis of butterfly valve disc. Modelling of the valve was done by CATIA V5 followed by discretization and then boundary conditions were applied and then results were obtained. The results show that there is provision for optimization of design.

**Dong-Soo Kim et.al. (2008)** investigated the safety of the ball valve [10]. Ball valve which is used for controlling natural gas was tested for the supply pressure and operating temperature. Mechanical properties such as stress, deformation and vibration Charactertics were considered for safety and durability in the preliminary design stage. Structural integrity of the valve was investigated by comparing the analytical and computational results.

**G. Aragón-Camarasa et.al. (2008)** presented the experimental work pertaining to the valve flow coefficient [11]. A test bench was carried for finding the valve flow coefficient numerically according to the ANSI/ISA-75.02-1996 regulations. The equation for the flow coefficient was obtained by equating the conditions of Euler's no for the prototype and test specimen.

**Xue Guan Song et.al. (2007)** worked on the flow Charactertics of the butterfly to estimate the performance [12]. With the help of CFX different flow patterns were obtained to measure the flow coefficient and hydrodynamic torque coefficient with various opening degrees and constant incoming velocity. The above method used was also useful in determining the process of valve flow along with accuracy.

**Lina Bryukhova et.al. (2012)** this paper describes the work pertaining to the tightness and stress analysis of the valves that are used in the nuclear power plant [13]. The detailed analysis was done in ANSYS Workbench v14.

**Dr. K.H. Jatkar et.al. (2013)** presented the paper on carrying out finite element analysis for critical components of the gate valve[14].the model of the valve was developed in CATIA V5R17 followed by analysis in ANSYS 11.Validation for the results obtained is done by classical theory of mechanics.

**Deokar Vinayak Hindurao et.al. (2010)** investigated the problem of analysis of plug valve body followed by validation with experimental results using strain gauge method for weight optimization. Weight reduction is done on the valve by changing the wall and rib thickness. The results showed that the valve was safe fort he applied load.

## III. GAP IDENTIFICATION

Analysis of valves has been carried out by researchers for finding the flow Charactertics of the valve, determining the flow coefficient and head loss coefficient. The research work carried on the mainly includes FEA analysis, CFD analysis on butterfly valves and globe valves. FSI analysis on globe valve has been carried out only for determination of flow Charactertics and no measures for improving the flow coefficient and its significant effect on the strength of the valve. For every opening of the valve its significant effect on the strength of the valve was not investigated. Following points were also not covered by reference researchers.

- ✓ Considering the effect of flow coefficient on the valve body
- ✓ Obtaining the pressure distribution for available flow for each incremental opening of the valve.
- ✓ Comparison of experimental flow coefficient and flow coefficient through analytical method for globe valve.

- ✓ Design of the according to FSI analysis.
- ✓ Guidelines for achieving maximum flow coefficient.
- ✓ Manually meshing the valve body instead of generating Automesh.
- ✓ Analysis of the valve according to FSI (Fluid Structure Interaction) analysis.

## IV. CONCLUSION

From the literature it is found there are remarkable works carried out in the field of analysis of valves. FEA, CFD and FSI were carried out for gate valve and butterfly valve. But that work carryout only for determination of flow Charactertics and other performance measures. Fluid structure interaction (FSI) is one of the emerging areas of numerical simulation and calculation. There is scope for researching the accurate performance of the valve and hence the combination of CFD with the structural analysis i.e. an FSI analysis must be considered.

## V. REFERENCES

[1] G.Tamizharasi And S.Kathiresan, 2013. ''CFD Analysis Of A Butterfly Valve In A Compressible Fluid'', Middle-East Journal Of Scientific Research 15, pp: 1834-1839.

[2] V. J. Sonawane1, T. J. Rane, A.D. Monde, R.V. Vajarinkar, P. C. Gawade. ''Design And Analysis Of Globe Valve As Control Valve Using CFD Software'', IOSR Journal Of Mechanical And Civil Engineering (IOSR-JMCE), pp: 63-71.

[3] Arun Azad, Deepak Baranwal, Rajeev Arya, Nilesh Diwakar, 2014. ''Flow Analysis Of Butterfly Valve Using CFD'', IJMER, Vol. 4, pp: 50-56.

[4] K Thanigavelmurugan, N.V.Mahalakshmi, S. Mohan Das, D. Venkatesh, 2012. ''Performance Improvement Of A Control Valve Using Computational Fluid Dynamics'', Proceedings Of The National Conference On Trends And Advances In Mechanical Engineering, pp: 106-113.

[5] Yong H. Yoo, Hyun W. Lee, Sang H. Cho , Kune Y. Suh, Jung Y. Yoo,2006.'' Engineering Analysis of Flow Characteristic Curve For Steam Turbine Control Valve", Transactions Of The Korean Nuclear Society Autumn Meeting gyeongju, pp: 1-2.

[6] Xue Guan Song, Lin Wang And Young Chul Park, 2009''Fluid And Structural Analysis Of A Large Diameter Butterfly Valve", Journal Of Advanced Manufacturing Systems, Vol. 8, No. 1, pp: 81-88.

[7] Balpreet Singh, Dr Gurudutt Sahni, 2014. ''Behavior Analysis Of Stainless Steel Globe Valve Under Different Temperature Conditions Using FEA", International Journal Of Engineering And Innovative Technology (IJEIT), Vol 3, pp: 113-116.

[8] Q. Yang, Z. Zhang, M. Liu, J. Hu, 2011. ''Numerical Simulation Of Fluid Flow Inside The Valve", Procedia Engineering, 23, 543-550.

[9] A. T. Bhosale 1, A. S. Dhekane, 2013. ''Finite Element Analysis of Butterfly Valve Disc", International Journal of Engineering Research & Technology (IJERT), Vol 2, pp: 2110-2114.

[10] Dong-Soo Kim, Myoung-Sub Kim, 2008. ''Analysis And Design Of Cryogenic Ball Valve", Proceedings Of The 7th JFPS International Symposium On Fluid Power, pp: 397-402.

[11] G. Aragón-Camarasa, G. Aragón-González, ''Experimental Determination Of The Flow Capacity Coefficient For Control Valves Of Process", Latin American Applied Research, pp: 57-63.

[12] Xue Guan Song, Young Chul Park, 2007. ''Numerical Analysis of Butterfly Valve-Prediction Of Flow Coefficient and Hydrodynamic Torque Coefficient", Proceedings Of The World Congress On Engineering And Computer Science.

[13] Lina Bryukhova, Jiri Taborsky, 2012. ''Stress Analysis Of Valves For Nuclear Power Plants", 20th SVSFEM, pp: 1-7.

[14] Dr. K.H. Jatkar, Sunil S. Dhanwe, 2013. ''Finite Element Analysis Of Gate Valve", International Journal Of Engineering And Innovative Technology (IJEIT), Vol 2, pp: 277-281.

[15] Deokar Vinayak Hindurao, D.S.Chavan''Optimization Of 16" Plug Valve Body Using FEA And Experimental Stress Analysis Method" International Journal Of Mechanical Engineering, Vol 1, pp: 79-83.

[16] Prof. Koli G.C., Prof. Katkar A.A. ''FSI Approach Study & Analysis", IOSR Journal Of Mechanical And Civil Engineering (IOSR-JMCE), pp: 09-15.